THE UNIVERSITY OF ALBERTA

Upper Jurassic and Lower Cretaceous Stratigraphy Along Cache Creek, N.W.T.

by

© Richard Alexander Fedoruk

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Beautiful night on the Mackenzie Delta

Typical day on the Mackenzie Delta

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Upper Jurassic and Lower Cretaceous Stratigraphy Along Cache Creek, N.W.T. submitted by Richard Alexander Fedoruk in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in Geology.

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Supervisor

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Date..14 April 1980.....

ABSTRACT

Strata exposed along Cache Creek, N.W.T. represent some of the most northeasterly exposures of Mesozoic rock on the west flank of the Mackenzie Delta. Based on examination of twenty-two outcrops along Cache Creek, with reliance on paleontology for age determination and Formation/division identification, the stratigraphic column for this area was determined and the general lithology of each Formation/division was described.

Approximately 1345 metres of Upper Jurassic (Oxfordian) through Lower Cretaceous (Aptian) strata are present. The Husky Formation, of which only siltstones and sandstones of its lower member crop out, comprises the basal 500 metres. Conformably(?) overlying the Husky Formation are approximately 130 metres of buff sandstone member strata from the lower sandstone division. Quantitative analysis by point counting shows this sandstone to be predominantly a sublitharenite having porosity of 0 to 18 percent. This arenaceous unit is conformably(?) overlain by at least 630 metres of upper shale-siltstone division strata. They are composed of the lower member, dominantly siltstone, and the more arenaceous upper member. The upper member of this division contains numerous geological oddities called stellate nodules, or 'hedgehog' concretions. Upper sandstone division strata of Aptian age comprise the youngest identified sediments. About 85 metres of this quartzarenite

are present. It has porosity of 0 to 18 percent.

Comparison of the stratigraphic column at Cache Creek with equivalent strata in three adjacent wells, Shell Beaverhouse Creek H-13, Shell Unak B-11 and Shell Ulu A-35, suggests strong influence on local sedimentation by the Cache Creek High throughout Late Jurassic and Early Cretaceous time.

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1. INTRODUCTION

1.1 Location of Study Area

The area of study is located along the lower portion of Cache Creek (Figure 1), in the District of Mackenzie, Northwest Territories. It lies at the most northerly edge of the Richardson Mountains and is bounded by the Mackenzie Delta to the northeast and the Yukon Coastal Plain to the northwest.

Topography in this area is mature, with elevations ranging from 30 to 300 metres above sea level. Outcrop is rare other than that occasionally exposed in the river valleys. Well developed tundra constitutes much of the vegetation, although small forest communities do exist in some sheltered valleys.

1.2 Purpose of Study

The west flank of the Mackenzie Delta consists predominantly of Mesozoic clastic sediments. To date, stratigraphic mapping of these rocks has concentrated in the area of the Aklavik Range (Figure 1), and throughout the western, central and eastern Richardson Mountains (Figure 1). Examination of the northern portion of the Richardson Mountains has been limited to regional reconnaissance.

The pupose of this study was to examine the geology along Cache Creek (Figure 1) on the northeastern flank of the Richardson Mountains, and to relate the local

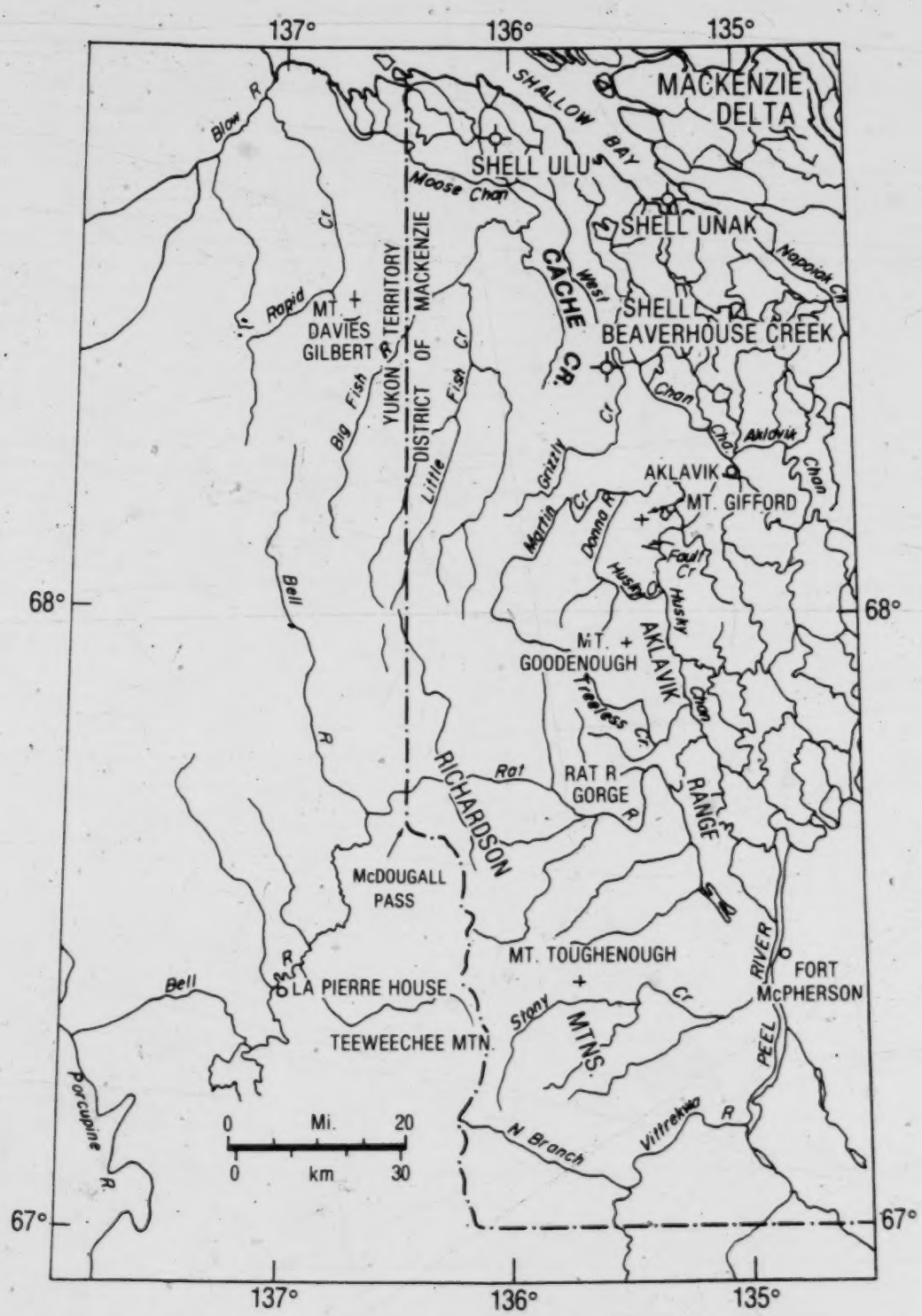


FIGURE 1. LOCATION MAP (after Jeletzky, 1967)

stratigraphy to that beneath the Mackenzie Delta. Some of the most northeasterly exposures of Mesozoic rocks are present along Cache Creek. For this reason, and because three exploratory wells, Shell Beaverhouse Creek, Shell Unak and Shell Ulu (Figure 1) are in close proximity to the area, Cache Creek was chosen for study.

The principal objectives of the study were:

1. To map the geology along Cache Creek and to identify the stratigraphic units present.
2. To examine and describe the general lithology of each of the stratigraphic units.
3. To establish the local stratigraphic sequence and its age based on the measured sections and their paleontological content.
4. To relate the local stratigraphy to the stratigraphy of the adjacent Mackenzie Delta stratigraphy as displayed in the three exploratory wells listed above.

1.3 Previous Work

The first reference to the geology of the Mackenzie Delta area was made by Isbister (1845). Petitot (1875) and Ogilvie (1887-88) also briefly mentioned geological features of this area noted during their travels through it.

An expedition led by McConnell (1891) in 1888 and 1889 on behalf of the Geological Survey of Canada provided the first accurate account of the geology in a portion of the northern Richardson Mountains. McConnell's party travelled

from Fort McPherson across the Richardson Mountains to LaPierre House, then down the Bell and Porcupine Rivers (Figure 1). Another geological party led by Camsell (1906) studied the geology along the Peel River, and in the vicinity of Mount Goodenough and McDougall Pass. Subsequent visitors to the area were O'Neill (1924), Nauss (1944) and Richards (1950). The presence of Upper Jurassic or Lower Cretaceous strata in the Mount Gifford and Donna River areas, and of Lower Cretaceous rocks on Mount Goodenough was established by these geologists. Their findings have been summarized by Hume and Link (1945) and by Hume (1954).

In 1954 Gabrielse (1957) conducted a regional geological reconnaissance in the northern Richardson Mountains. The following year, J.A. Jeletzky of the Geological Survey of Canada commenced a biostratigraphic study of the region and in his publication of 1958, he established the first divisions of Jurassic and Cretaceous strata in the Mount Goodenough area. From his subsequent work (Jeletzky 1960, 1961b, 1967), he modified his original units and introduced several new divisions. The significance of fossils to understanding the regional geology was realized by Jeletzky (1961b, p. 3) wherein he stated that:

> "Although all of the proposed 'lithological' units are sufficiently distinct from the adjacent rock units of the sequence, none is so different that it can be safely distinguished on lithology alone from lithologically similar

> units in other parts of the geological column of the area. The same is true of all the recurrent pairs of rock units. Under these circumstances, safe recognition and lateral extension of all these rock units within the area depends on the determination of their relative age by means of the set of fossil zones previously worked out on the eastern slopes of Richardson Mountians (Jeletzky, 1958a, 1960), but found to be equally valid on the western slopes.
>
> ...the conclusions, which are incidentally equally valid for all other areas of the Richardson Mountains investigated by the writer, indicate that one should rely not on lithology but on fossils when mapping the Upper Jurassic and Lower Cretaceous rocks of the western slope of the Richardson Mountains."

The writer is aware that the manner in which Jeletzky has established these stratigraphic units is not in keeping with the definition of a lithostratigraphic unit as defined by the American Commission on Stratigraphic Nomenclature (1970). By definition, a rock-stratigraphic (lithostratigraphic) unit is a subdivision of rocks distinguished solely on the basis of lithology; its recognition is independent of inferred geological history, biologic sequences and time. However, because of the wide usage of Jeletzky's stratigraphic units and the absence of

an alternative set of units, the writer has employed them, with the associated reliance on paleontology (age) for their recognition.

More recent work by Jeletzky (1971a, 1971b, 1972, 1974, 1975c) has centred on paleogeographic interpretations of the northern Yukon and northwest District of Mackenzie from outcrop data.

Norris conducted structural studies in the region. His independent work (Norris, 1973, 1974, 1975, 1976, 1977, 1978) and the results from the Geological Survey of Canada Operation Porcupine, of which he was leader, contributed greatly to the structural and tectonic knowledge of the region.

Current work in the Mackenzie Delta area is concentrated on subsurface stratigraphy and biostratigraphy. Brideaux et al. (1975,1976) examined the biostratigraphy of a number of exploratory wells. Brideaux and Fisher (1976) and Brideaux and Myhr (1976) conducted studies of dinoflagellates from the subsurface. Foraminiferal assemblages were studied from subsurface and surface lithologies by Mountjoy and Chamney (1969) and Chamney (1971).

Lithostratigraphic interpretations of Cretaceous strata have been made by Cote et al. (1975), Myhr (1974, 1975) and by Myhr and Young (1975). Similar work on Jurassic strata has been performed by Poulton and Calloman (1976) and by Poulton (1978). Young (1971, 1972, 1973) studied the

Cretaceous stratigraphy in the northern Yukon and northwestern District of Mackenzie.

The regional geology, incorporating paleogeography, has been independently interpreted by several persons. Jeletzky has examined this subject in his more recent publications (1971a, 1971b, 1972, 1975c). Lerand (1973) discussed the entire Mackenzie and Beaufort Basins and summarized their geological events since Cambrian time. A similar effort by Young et al. (1976) presented the geology of the Beaufort-Mackenzie Basin from Triassic to Tertiary time. This comprehensive study incorporated outcrop data and subsurface information from 35 exploratory wells. It is the most current interpretation of the geology of this region, and is favoured by the writer over other interpretations.

Numerous oil companies have been actively searching for hydrocarbons in the Mackenzie Delta area since the mid-1960's. While their surface exploration results remains confidential, much information from their exploratory wells is available to the public through government agencies, particularly the Geological Survey of Canada. This exploration activity has contributed greatly to the geological understanding of the region.

1.4 Methodology

1.4.1 Field operations

In the summer of 1977, the writer was employed as a geologist by Petro-Canada Exploration Inc. to participate in

a geological mapping expedition in the northern Richardson Mountains. During the 25-day geological program the writer spent several days mapping and sampling in the study area. Field operations were hampered by unseasonably cold weather (see Frontispiece). Rain and snow persisted throughout much of the field season. The abundant precipitation resulted in high water levels in the rivers and streams making access to outcrops difficult. Outcrops, especially the shale units, were occasionally obscured by slumping.

Access to the study area was by a Bell 206 Jet Ranger helicopter. The extensive tundra cover between the outcrops made walking very difficult, therefore the helicopter was also used to move between the outcrops.

Twenty-two outcrops were examined along Cache Creek. Where there was sufficient exposure, the true thickness of the outcrop was measured with a 1.5m jacob's staff, and, where possible, the dip and strike were measured with a Brunton compass. The outcrops were sampled for lithology, macrofossils, microfossils, and palynology. A complete description of each measured section, showing sample locations, is provided in Appendix 1.

1.4.2 Lithological Study

A total of 57 lithological samples were collected and thin sections were made from each one. All thin sections and their accompanying hand samples were studied qualitatively, while 52 thin sections were chosen for quantitative analysis

by point counting. These slides, which were prepared by Petro-Canada Exploration Inc., had been stained for carbonate identification with alizarin red and impregnated for porosity determination. The writer subsequently stained the slides with sodium cobaltinitrite to highlight potash feldspar prior to carrying out a 300 grain point count of each. Essential components and porosity were quantitatively examined; the dominant cements were determined by visual inspection. The tabulated results of the quantitative analyses are presented in Appendix 2.

The objective of the quantitative study was to determine the general composition of the rock. Essential components of the slides were assigned to three categories, in accordance with a classification scheme proposed by Folk (1974, pp. 128,130). The quartz pole consists of all types of quartz including metaquartzite (but not chert). The feldspar pole includes all single feldspars (K or Na-Ca), as well as feldspathic granite and gneiss fragments. Chert, slate, schist, volcanics, limestone, sandstone, shale and siltstone are all assigned to the rock fragment pole. The percentage is calculated on 100% of the essential components and the resulting rock clan is determined according to the diagram in Appendix 2.

1.4.3 Bed Thickness Determination

Ideally, the thickness of a lithological unit can be measured directly in the field. However, the very poor

exposure in the study area necessitated calculation of bed thickness by indirect means. This indirect method, presented by Kilby (1978, pp. 34,35), employs a computer program to calculate the thickness of strata between two data points (outcrops). This method was used to determine the thickness of strata between outcrops, assuming stratigraphic continuity between them. Since no bed contacts were observed in the study area, the writer estimated the probable position of contacts. Where thickness was calculated between an outcrop and a fault, the bedding orientation was assumed to be constant between them.

1.4.4 Determination of Outcrop Age

Three disciplines of paleontology were employed for age determination. Macropaleontology, the study of fossils large enough for unaided visual observation, is the most refined of the three in this region. J.A. Jeletzky, who pioneered biostratigraphic studies in the area, has developed a Buchia zonation upon which the regional stratigraphy is founded.

Micropaleontology, the study of foraminifera, is much less refined as a correlative and biochronological tool. Though micropaleontology studies have been carried out by officers of the Geological Survey of Canada, by several graduate students at the University of Alberta (Davidson, 1960; Hedinger, 1979), and by a number of oil companies, no complete foraminiferal zonation has been established for the Upper Jurassic through Lower Cretaceous

strata in the region. Palynology, the study of pollen and spores, is still in its developing stages. Brideaux et al. (1975, 1976, 1976) and McIntyre (1974) have carried out palynological investigations in the MacKenzie Delta area, but no general zonation has been established. Palynology, though useful on a limited, local scale, is the least precise of the three diciplines.

1.4.4.1 Sample collection and processing

1.4.4.1.1 Macropaleontology

Macropaleontological samples were collected at nine sites in the study area. Pelecypods (principally Buchia) constitute the majority of the fossils, but belemnites were present at several locations. Macrofossils were largely restricted to the arenaceous outcrops; however, in RF 1 and RF 18, belemnites were found in the argillaceous sediments. Fossil identification and age assignment were performed by J.A. Jeletzky of the Geological Survey of Canada. These results, accompanied by his opinion as to the probable host lithological unit, are documented in Appendix 3.

1.4.4.1.2 Micropaleontology

Micropaleontological samples were collected at 16 locations in the study area. Identification and age assignment were carried out by P.F. Sherrington of Petro-Canada Exploration Inc. According to Sherrington(pers. comm.), many of the fauna from the study area are new

species, yet to be described and classified. Consequently, the ages cited here are based only on a zonation established by Sherrington for the the Richardson Mountains area. This zonation and the accompanying faunal identifications are presented in Appendix 4.

1.4.4.1.3 Palynology

Palynological samples were collected at the same sites as micropaleontological samples. Of the 16 locations sampled, 11 yielded identifiable and datable flora. The palynological study was carried out by B.G. van Helden of Chevron Standard Ltd. The floral identification, age assignment and their zonation chart are included in Appendix 5.

1.4.4.2 Age Assignment

The ages derived from the macrofossils are displayed in Figure 2. Outcrops in the study area contain macrofossils ranging in age from latest Oxfordian (Late Jurassic) to Aptian (Early Cretaceous). However, the poor quality of preservation and/or the non-diagnostic nature of some fauna often restricted the accuracy of age assignment.

The outcrops sampled yielded formanifera ranging in age from Oxfordian to Aptian (Figure 2). Many of these fossils are poorly preserved, consequently age assignment is at times very general and on occasion no assignment is possible.

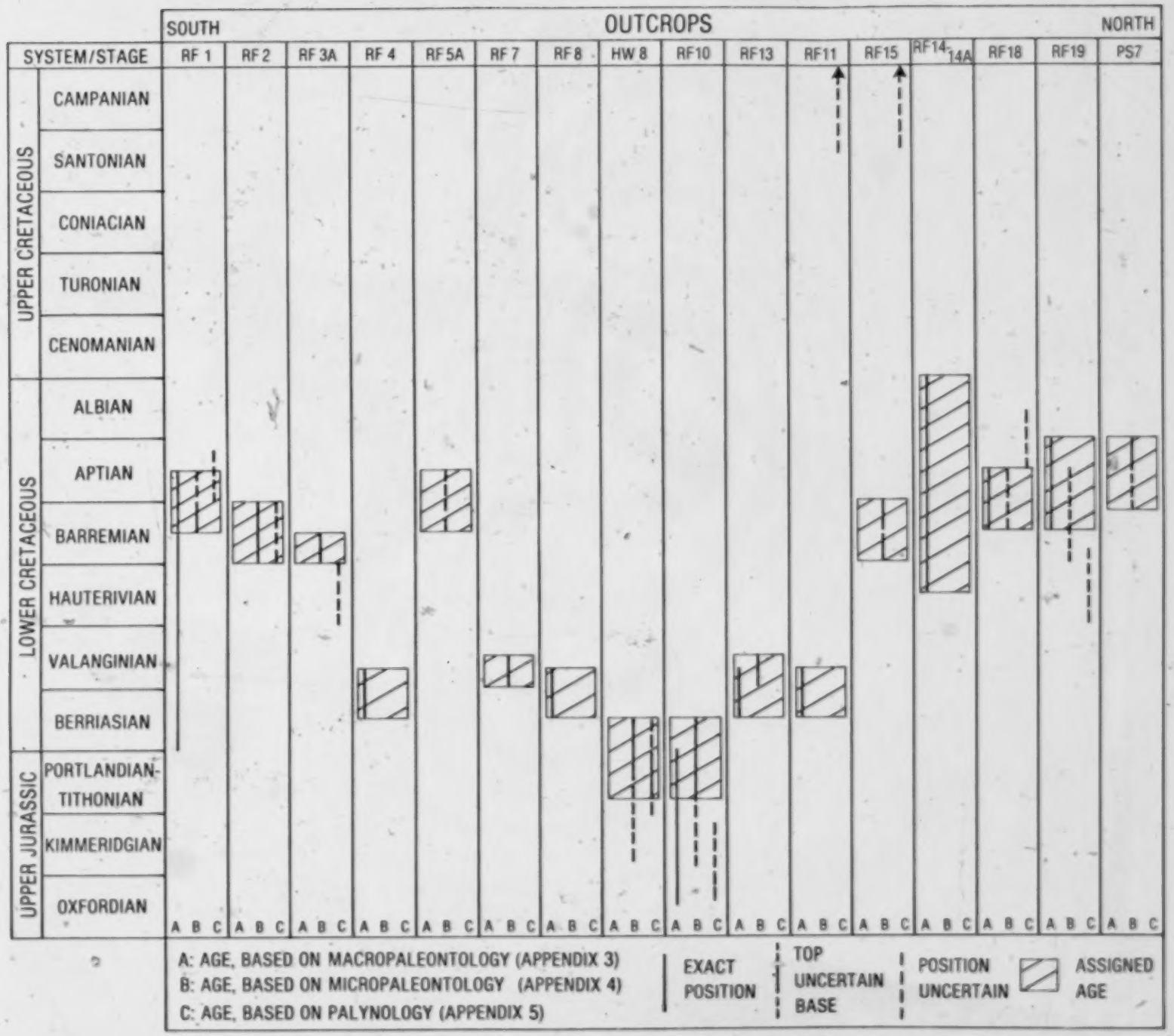


FIGURE 2. AGE OF OUTCROPS

The age of flora recovered in the study area varied substantially, from Oxfordian to Late Cretaceous (undifferentiated). These fossils are also poorly preserved, consequently their age assignments (Figure 2) are often approximate.

As evident from Figure 2, the agreement of age determinations within the outcrops is often poor. Although the exact age of each outcrop cannot be determined from the inadequate biochronological data, the most likely age of each outcrop as interpreted by the writer is shown in Figure 2.

2. GEOLOGICAL SETTING

2.1 Regional Stratigraphy

The Mesozoic stratigraphy of the northern Richardson Mountains has been well established by Jeletzky (1958, 1960, 1961b). Based primarily on fossil zonation and lithology, he has subdivided the predominantly marine uppermost Jurassic and Lower Cretaceous strata into six divisions, the lowest one having subsequently been elevated to formation status. The stratigraphic succession is as follows: Husky Formation of latest Jurassic and earliest Cretaceous age; lower sandstone division of Early Cretaceous age; coal-bearing division of early to middle Early Cretaceous age; upper shale-siltstone division of middle Early Cretaceous age; upper sandstone division of middle to upper Early Cretaceous age; Albian shale-siltstone division of Albian age. This succession is shown in Table 1.

2.1.1 Husky Formation

The Husky Formation (Jeletzky, 1967, p. 26); formerly known as the lower shale-siltstone division (Jeletzky, 1958, p. 3) consists mainly of dark grey, blackish grey to brownish grey shale and siltstone. Occasional interbeds of sandstone, gritty to pebbly sandstone and rare nests or layers of Buchia coquina are present. Ironstone concretions and bands are common throughout the succession. The Husky Formation is subdivided into four members, in ascending

ERA	SYSTEM	STAGE	FORMATION/DIVISION	
MESOZOIC	LOWER CRETACEOUS	ALBIAN	ALBIAN SHALE - SILTSTONE DIVISION	
		APTIAN	UPPER SANDSTONE DIVISION	
		BARREMIAN	UPPER SHALE – SILTSTONE DIVISION	UPPER MBR. LOWER MBR.
		HAUTERIVIAN	COAL-BEARING DIVISION	UPPER MBR. LOWER MBR.
		VALANGINIAN	LOWER SANDSTONE DIVISION	WHITE SS MBR. SHALE MARKER BUFF. SS MBR.
		BERRIASIAN		
	UPPER JURASSIC	PORTLANDIAN - UPPER TITHONIAN	HUSKY FORMATION	UPPER MBR. RED WEATHERING SHALE MBR.
		KIMMER - IDGIAN		ARENACEOUS MBR.
		OXFORDIAN		LOWER MBR. (RESTRICTED)

TABLE 1. TABLE OF FORMATIONS

order the lower member, the arenaceous member, the red-weathering shale member and the upper member.

The lower member is restricted to rocks between the top of the Bug Creek Formation and the base of the arenaceous member. Its lower contact is always sharp and uneven, but it does not appear to be an erosional contact and may reflect a period of rapid regional subsidence accompanied by etching of the surface of the Bug Creek Formation (Jeletzky, 1967, p. 29). The upper contact with the arenaceous member is gradational and conformable. The lower member consists predominantly of shale, silty shale and a variety of siltstones ranging in color from blackish to brownish to light grey. The thickness of this unit is estimated to be from 229 to 247 metres (Jeletzky 1967, p. 32) throughout the Aklavik Range (Figure 1).

The arenaceous member consists mainly of fine grained and rarely coarse grained to gritty and pebbly sandstone. Interbedded with the sandstone is an approximately equal amount of sandy to gritty and pebbly siltstone and occasional shale. Most rocks are drab grey, except for the uppermost part of the member which is composed of greenish grey to blackish green glauconitic sandstone and siltstone. This member may be as much as 40 metres thick (Jeletzky 1967, p. 31). Though the contact with the overlying red-weathering shale member is abrupt, it appears to be conformable and is locally gradational.

The red-weathering shale member is composed of shale

which is often calcareous, and of numerous mostly calcareous clay ironstone bands and concretions. This member, which is light to dark grey or brownish grey in color, is often distinctly banded or laminated and fossiliferous (Jeletzky, 1967, p. 30). The red-weathering shale member is thought to be about 30 metres thick (Jeletzky 1967, p. 30) in the central Aklavik Range, and is believed to underlie conformably and gradationally the upper member.

The upper member consists of alternating dark sandy siltstone, lesser amounts of lighter grey silty sandstone and dark grey to black shale. Near the top of the member, occasional interbeds of light grey to buff sandstone occur. The upper member is differentiated from the underlying red-weathering shale member by its general dark grey to black color. Concretions in this member also tend to be grey to dark grey. The upper member which may be in excess of 61 metres thick (Jeletzky 1967, p. 29), is in gradational contact with the overlying lower sandstone division.

The shale and siltstone succession of the Husky Formation is well developed in the central and northern Aklavik Range and in the Mackenzie Delta. At Jeletzky's (1967, p. 26) type section on Husky Creek (Figure 1) the Husky Formation is approximately 400 metres thick (Jeletzky, 1958, pp. 18-27; Jeletzky 1961b, Fig. 10), while to the north it is thought to be somewhat thinner (Jeletzky 1967, p. 28).

According to Jeletzky (1967, pp. 33-36) the Husky

Formation extends from the early Oxfordian of Late Jurassic age to the early Berriasian of Early Cretaceous age (Table 1). The Jurassic-Cretaceous boundary is assumed to lie between the red-weathering shale member and the arenaceous member (Table 1).

In the northwestern Richardson Mountains, the Husky Formation grades into the shale of the Kingak Formation (Table 2). In the Porcupine and Bell River areas (Figure 1), it is equivalent to and interfingers with the unnamed Upper Jurassic sandstone division (Jeletzky 1974, p. 8), which has been informally called "Porcupine sandstone" (Lerand 1973, Figure 35). Towards the southwest, in the area of the Vittrekwa River (Figure 1), the Husky Formation becomes increasingly arenaceous, with this facies comprising the coaly and conglomeratic North Branch Formation (Jeletzky 1967, p. 41).

2.1.2 Lower Sandstone Division

The lower sandstone division (Jeletzky, 1958, p. 7; Jeletzky, 1960, pp. 5,6) is predominantly a thick cliff-forming sandstone succession. This marine unit is subdivided into two members, the buff sandstone member and the white sandstone member. These are separated by a thin argillaceous unit informally called the shale marker (Cote et al., 1975, p. 623).

The buff sandstone member consists of buff to light yellow, fine grained, thinly bedded to laminated quartzose

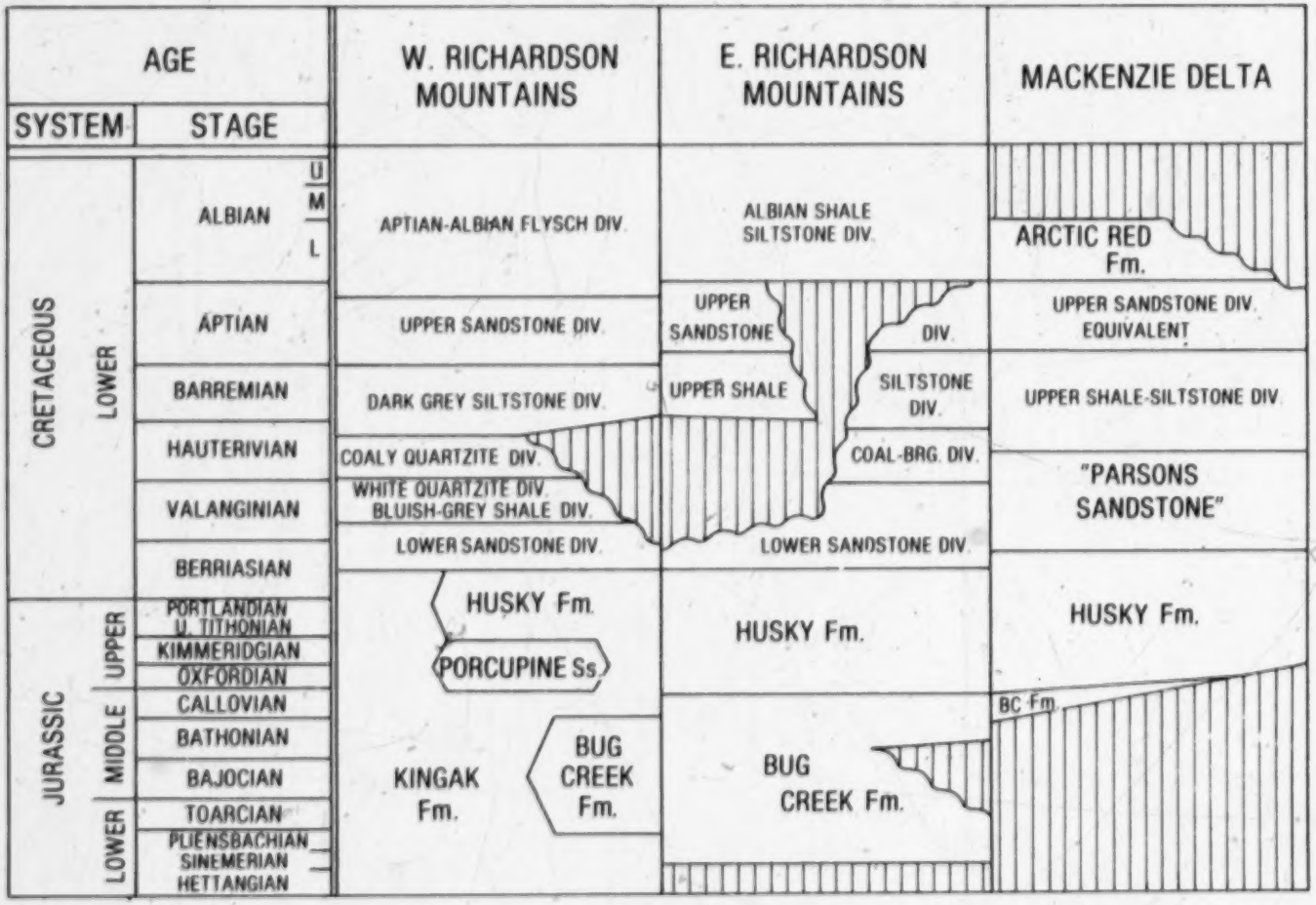


TABLE 2. CORRELATION CHART

(after Jeletzky, 1961b. Young et. al., 1976)

and micaceous sandstones. Dark grey sandy siltstones and shale are present as minor beds and layers. The contact with the underlying Husky Formation is gradational and the member is conformably overlain by the shale marker. The buff sandstone member is estimated to be about 105 to 110 metres thick at Fault Creek (Figure 1) (Jeletzky 1958, p. 7), while to the north at Grizzly Creek (Figure 1), an almost complete exposure of this member was found to be approximately 88 metres thick (Myhr et al., 1975, p. 249).

The shale marker is a thin shale and siltstone unit of uniform thickness, about 24 metres thick (Cote et al., 1975, pp. 623,627), which is equivalent to the bluish-grey shale division of the western Richardson Mountains (Jeletzky 1961, p. 14). Conformably overlying this unit is the white sandstone member.

The white sandstone member is composed of a thick succession of grey to whitish grey, fine to coarse grained quartzose sandstones. Well developed crossbedding and concretionary zones are displayed in this unit. It is estimated to be 46 to 52 metres thick at Fault Creek (Jeletzky 1960, p. 5); at Grizzly Creek it is locally absent, but appears as a feather-edge, thickening to the northeast (Young, 1978, p. 81).

The lower part of the buff sandstone member is of late Berriasian age while its uppermost beds are early Valanginian (Table 1). The lowest beds of the white sandstone member also contain fossils diagnostic of early

Valanginian age, however it is thought to extend to late Valanginian age (Jeletzky, 1958, p. 8).

On the west flank of the Richardson Mountains, the buff sandstone member is correlative with the lower sandstone division; the shale marker corresponds to the bluish-grey shale division, and the white sandstone member is equivalent to the white quartzite division (Table 2). To the east, in the subsurface of the Mackenzie Delta, the entire lower sandstone division is included in the lower portion of the Parsons sandstone (Cote et al., 1975, p. 619). The Parsons sandstone, composed of the lower sandstone division and the overlying coal-bearing division, represents much of the Neocomian (Berriasian-Hauterivian) sequence in the Mackenzie Delta area (Myhr et al., 1975).

2.1.3 Coal-bearing Division

The coal-bearing division (Jeletzky, 1960, p. 7) is composed of a lower member, which is mainly sandstone with interbedded shales and coal, and an upper member consisting of sandstones. The lower member of this division consists of light to dark grey, carbonaceous to coaly sandstones which are irregularly interbedded with dark grey to bluish grey carbonaceous to coaly siltstones and shales. Several coal seams, each of which displays great variability in thickness and areal extent, occur within it. Thin intermittent beds, layers and inclusions of impure coal often accompany these seams. The non-marine lower member grades upward into the

predominantly marine upper member.

The upper member, which consists mainly of buff to rusty weathering, grey, fine to medium grained quartzose sandstones only rarely contains thin layers or small pods of carbonaceous to coaly sandstones or shale. The lower contact of the coal-bearing division, though accented by a sharp lithological change, is gradational (Jeletzky, 1960, p. 8). The upper contact varies from gradational to unconformable (Young et al., 1976, p. 19). The complete division, exposed at Donna River (Figure 1), is about 159 metres thick, but to the north it is much thinner (Jeletzky, 1960, pp. 7-8).

Age determination based on fossil zonation (Jeletzky, 1960, p.9) places the coal-bearing division at a latest Valanginian through Hauterivian age (Table 1). The coal-bearing division is correlative with the coaly quartzite division on the west flank of the Richardson Mountains (Jeletzky, 1961, p. 18). Its marine equivalent in the subsurface is the upper marine unit of the Parsons sandstone of the Mackenzie Delta (Cote et al., 1975, pp. 628-629).

2.1.4 Upper Shale-Siltstone Division

The upper shale-siltstone division (Jeletzky, 1958, p. 10) is a dark grey shale and siltstone sequence of marine origin which has been subdivided into lower and upper members. The lower member consists of blackish grey shales with an abundance of rusty weathering clay ironstone bands

and concretions. The upper third of this member is marked by thick beds and zones of fine grained, silty sandstone. The upper member is represented by grey sandy siltstones and silty sandstones, with minor beds of light grey to buff, fine grained sandstones.

The upper shale-siltstone division unconformably overlies the lower sandstone division and the Husky Formation in the southern Aklavik Range, where it is marked by a well developed basal conglomerate (Jeletzky, 1958, p. 10). In the northern Aklavik Range the contact is generally sharp and conformable (Jeletzky, 1960, p. 12), but locally can be gradational or unconformable(Myhr et al., 1975, p. 253). Its contact with the overlying upper sandstone division is transitional, represented by a zone of interbedded sandy siltstones and silty sandstones. The thickest development of the upper-shale siltstone division is west of the Bell River where about 1200 metres are exposed (Jeletzky, 1974, p. 13). In the central Richardson Mountains area, on the axis of the Cache Creek High, only 260 metres are present (Young, 1975a, p. 316).

The upper shale-siltstone division is generally considered to be of Barremian age (Table 1). The lower member of this division is Lower Barremian (Jeletzky, 1960, p. 13), while the upper member extends through the latest Barremian (Jeletzky, 1960, p. 13). The upper shale-siltstone division extends eastward into the Mackenzie Delta (Young et al., 1976, Table 1). On the west flank of the Richardson

Mountains it is equivalent to the dark grey siltstone division (Jeletzky, 1961b, p. 19).

2.1.5 Upper Sandstone Division

The upper sandstone division (Jeletzky, 1958, p. 10) is composed predominantly of fine to medium grained, well-sorted quartzose, and micaceous sandstone. These buff, rusty or light grey sandstones form several units 30 to 50 metres thick (Jeletzky, 1960, p. 13). They are interbedded with units of darker colored, fine grained, clayey to shaly sandstone, sandy siltstone, shale and clay ironstone of about the same thickness. These beds are occasionally accompanied by beds of strongly glauconitic sandstone. Lithologically, the upper sandstone division is indistinguishable from the lower sandstone division (Jeletzky, 1960, p. 14).

The upper sandstone division varies greatly in thickness and in its vertical sequence of facies (Young et al., 1976, p. 21). The thickest exposures are found in the western portion of the northern Richardson Mountains, notably along Big Fish River (Figure 1). There it is composed of lower and upper members (Jeletzky, 1974, p. 16). The lower member, dominantly sandstone, is 200 to 450 metres thick, while the dominantly siltstone upper member is 450 to 750 metres thick. In the axial and northern parts of the Cache Creek High, these two members are commonly 300 metres thick (Young et al., 1976, p. 21). In the Aklavik Range,

numerous sandstone units up to 60 metres thick alternate with silty, dark, bioturbated mudstones of similar thickness (Young et al., 1976, p. 21). Between Treeless Creek and Donna River (Figure 1), the lower and middle beds of the upper sandstone division are approximately 245 to 275 metres thick (Jeletzky, 1960, p. 14).

The lower part of the upper sandstone division is of latest Barremian age, while the middle and upper portion extends to late Aptian age (Table 1)(Jeletzky, 1960, p. 16). The upper sandstone division of the eastern Richardson Mountains is laterally equivalent to the upper sandstone division on the west flank of the Richardson Mountains and to the upper sandstone division equivalent in the Mackenzie Delta (Young et al., 1976, Table 1, p. 9). This relationship is shown in Table 2.

2.1.6 Albian Shale-siltstone Division

The Albian shale-siltstone division (Jeletzky, 1960, p. 18) is characterized by greenish grey to black hard shales and siltstones. Layers of clay ironstone concretions and interbeds of clay ironstone are common within it. The division lies unconformably on top of the upper sandstone division, with the contact often marked by a well developed pebble conglomerate.

The Albian shale siltstone division is widespread in the areas of the Peel and Vittrekwa Rivers, where it is from 244 to 305 metres thick, but in the northern Richardson

Mountains it is absent due to pre-Upper Cretaceous erosion (Jeletzky, 1960, p. 18). As its name implies, this division is of Albian age (Jeltezky, 1960, pp. 18-19). It is correlative with the Aptian-Albian flysh division in the northwest Richardson Mountains and with the Arctic Red Formation in the Mackenzie Delta (Table 2)(Young et al., 1976, Table 1, p. 9).

2.2 Tectonic Features

The Beaufort-Mackenzie Basin (Young et al., 1976) was strongly affected by the Columbian tectonic event of Late Jurassic to earliest Cretaceous time. The major elements of this period of tectonism are shown in Figure 3.

Two prominent landmasses, the Peel and the Keele-Old Crow landmasses strongly influenced sedimentation during much of this time. The Peel landmass, a broad exposed region, had as components the Eskimo Lakes Arch, Campbell Lake High, Rat High, Eagle Arch and Cache Creek High. These en echelon components together form the Aklavik Arch Complex (Norris, 1974, p. 32). The Eskimo Lakes Arch and Campbell Lake High formed a positive culmination on the northwestern flank of the Peel landmass. They were bounded to the northwest by the Kugmallit Trough which was the site of extensive Jurassic and Early Cretaceous sedimentation. The Cache Creek High, a positive element in the centre of the Jurassic and Early Cretaceous basin, affected sedimentation in the Kugmallit Trough to the south and in the Blow Trough

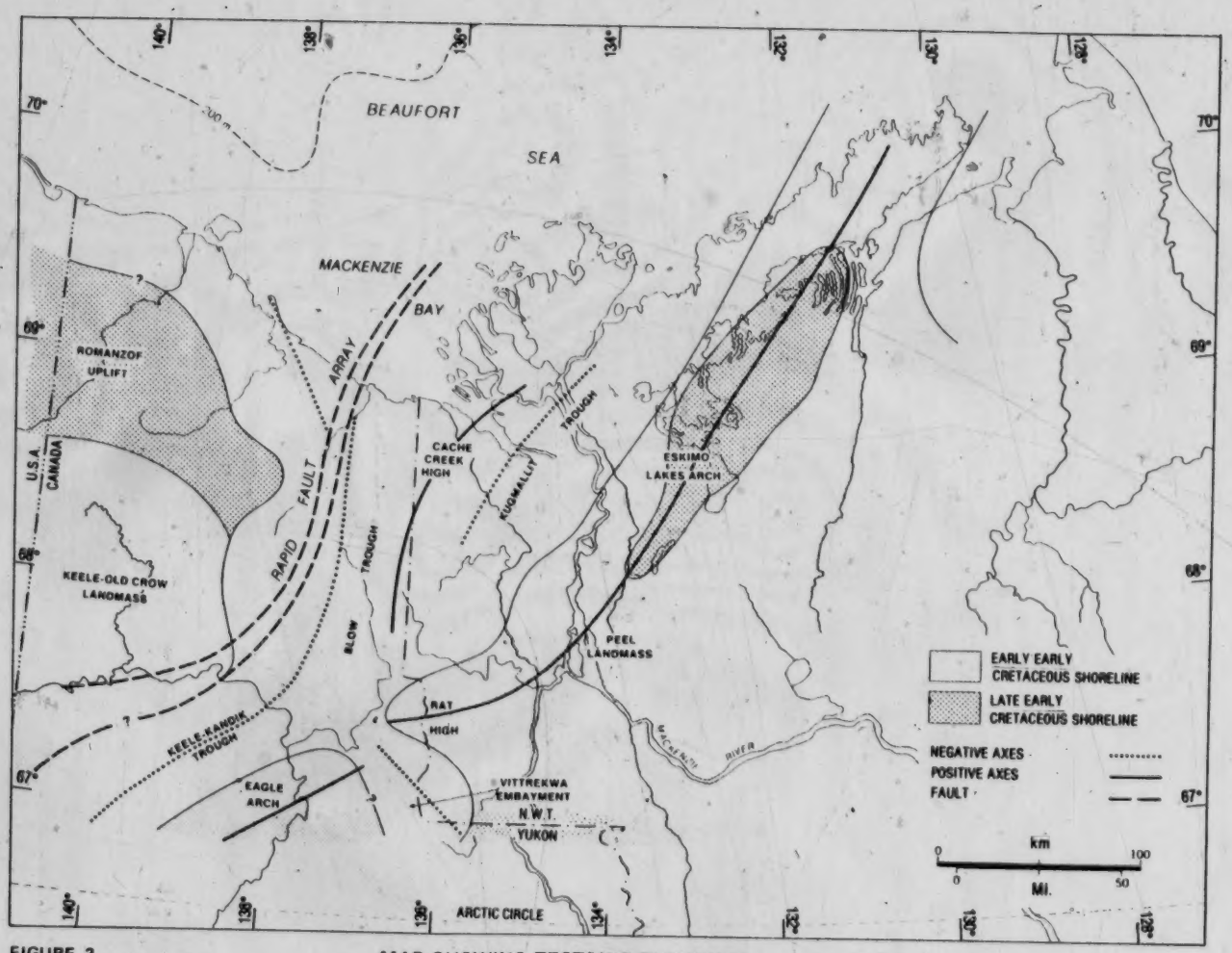


FIGURE 3

MAP SHOWING TECTONIC ELEMENTS

(after Young et al., 1976)

to the north. In the southern region, the Eagle Arch and Rat High controlled sedimentation in the Vitrekwa Embayment, a paleogeographic re-entrant of the Blow Trough.

The Keele-Old Crow landmass (Jeletzky, 1971a, 1972) is thought to represent the eastward expansion of the ancestral Brooks Range into western Yukon. Together with the Cache Creek High, it acted as a source of and influence on sedimentation in the Blow Trough. According to Young (1976) the Blow Trough is approximately equivalent to Jeletzky's Porcupine Plain-Richardson Mountains Marine Trough (Jeletzky, 1971b, p. 1). The Blow Trough is believed to connect with the Kandik Basin of east-central Alaska via the Keele-Kandik Trough (Young et al., 1976, p. 3), rather than to extend southward into the Eagle Plain as argued by Jeletzky (1975c, p. 3). The Rapid Fault Array is considered to be an extension of the Kaltag-Porcupine Fault. The right-lateral and vertical displacement along this bundle of faults in late Hauterivian time was a major influence on the regional geology (Young et al., 1976, p. 6).

Subsequent Late Cretaceous and Tertiary tectonism, part of the Laramide event, has modified the region to its present form.

2.3 Depositional History

Upper Jurassic through Lower Cretaceous sedimentation in the Beaufort-Mackenzie basin is characterized by two depositional phases. Initial deposition was an

epicontinental phase which included the Upper Jurassic and entire Lower Cretaceous sequence beneath the Mackenzie Delta and Tuktoyaktuk Penninsula (Young et al., p. 1; Young, 1978, p. 30). Characteristic sediments of this phase are shallow marine sandstones, near-shore clastics and neritic mudstones. In the central and western Richardson Mountains, the epicontinental phase gives way to a flyschoid phase that developed in middle Aptian time. Deep-water conglomerates and turbidite sandstones are interspersed within this predominantly shale and siltstone sequence.

During Late Jurassic time, the sea covered the Cache Creek High and transgressed onto the Eskimo Lakes Arch. It extended as far south as the Vittrekwa Embayment and to the west it onlapped the Keele-Old Crow landmass. Several major depocentres were dominant during this time. The Kugmallit Trough in the northeastern portion of the basin received a thick sequence of shales and siltstones (the Husky Formation) while to the west, in the Blow Trough, shales of the Kingak Formation were deposited. Though the Cache Creek High was not emergent during this time, its positive nature strongly influenced sedimentation in both of these areas, being responsible for the shallow-water deposition in the Kugmallit Trough. Continued subsidence in the Keele-Kandik Trough resulted in a very thick accumulation of sandstones informally known as the Porcupine sandstone. In addition to deposition at the head of the trough, sand was widely distributed northward over a shelf-like platform in the area

of the present Richardson Mountains (Young et al., 1976, p. 15). A similar arenaceous unit known as the North Branch Formation accumulated in the Vittrekwa Embayment. This general depositional pattern (Figure 4) persisted until latest Jurassic and earliest Cretaceous time.

During Berriasian time, an eastward transgression deposited marine shales over much of the Richardson Mountains area, but by late Berriasian time a slight regression resulted in shoaling and local emergence. Deltaic complexes in the east around Stony Creek, Vittrekwa River and Treeless Creek (Figure 1) acted as sources of coarse clastics which were widely distributed throughout the northeast and northwest. These clastics accumulated along the flanks of the Cache Creek High and Eskimo Lakes Arch; the thick accumulation of these sands in the Kugmallit Trough is informally called the Parsons sandstone. In the northwestern Richardson Mountains, Blow Trough and environs, coeval deposits are characterized by silty sandstones and siltstones. Figure 5 summarizes the upper Berriasian lithofacies in the area.

Uplift of the Eskimo Lakes Arch during Valanginian time induced the formation of large deltaic complexes along its northwestern flank. Much of the sediments accumulated in the Kugmallit Trough, further thickening the Neocomian sandstone sequence. To the west, the open marine conditions prevalent in the Blow Trough were represented by deposition of the bluish grey shale division. Mid-Valanginian uplift of the

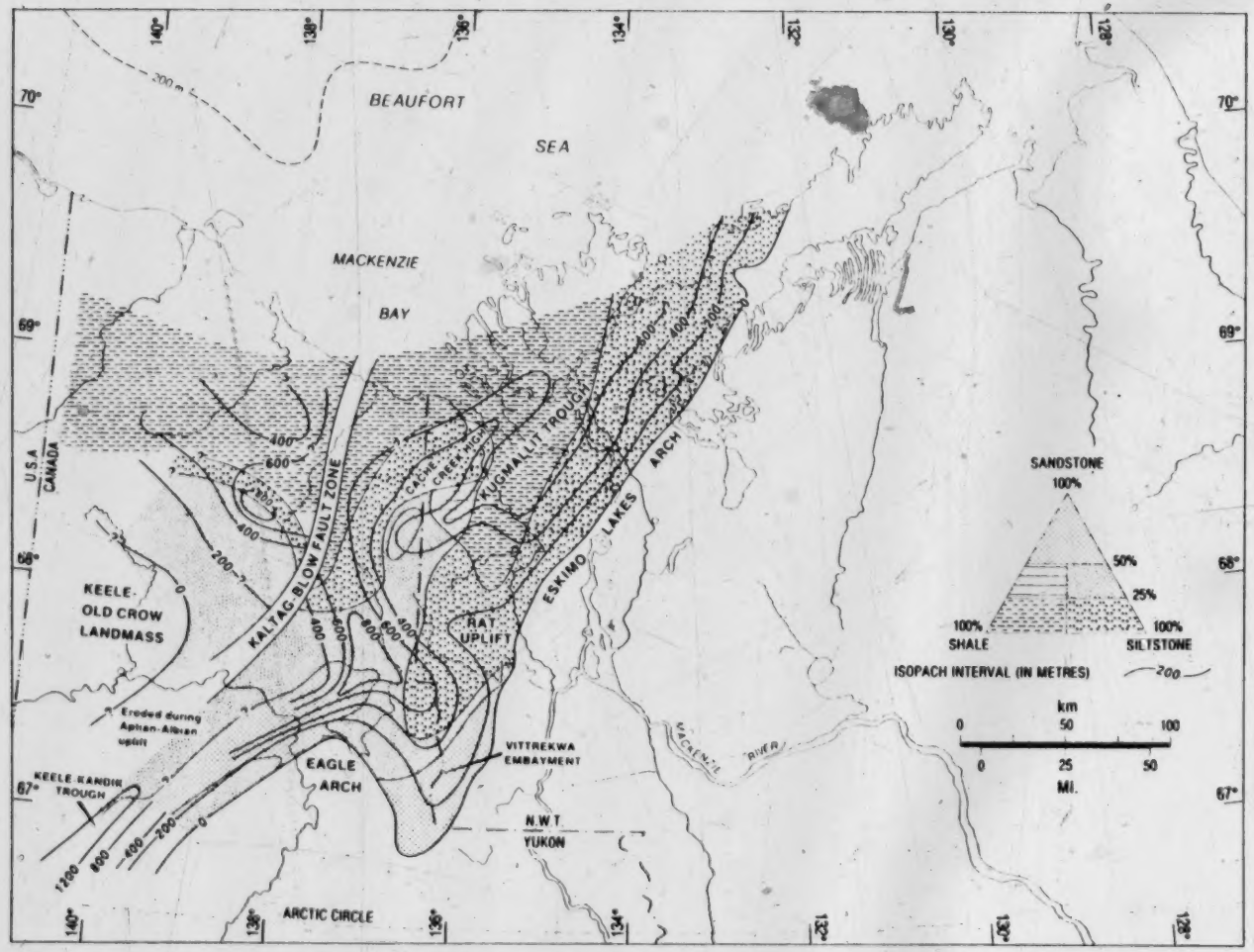


FIGURE 4 ISOPACH MAP OF UPPER JURASSIC SHOWING KIMMERIDGIAN-EARLY PORTLANDIAN LITHOFACIES
(after Young et al., 1976)

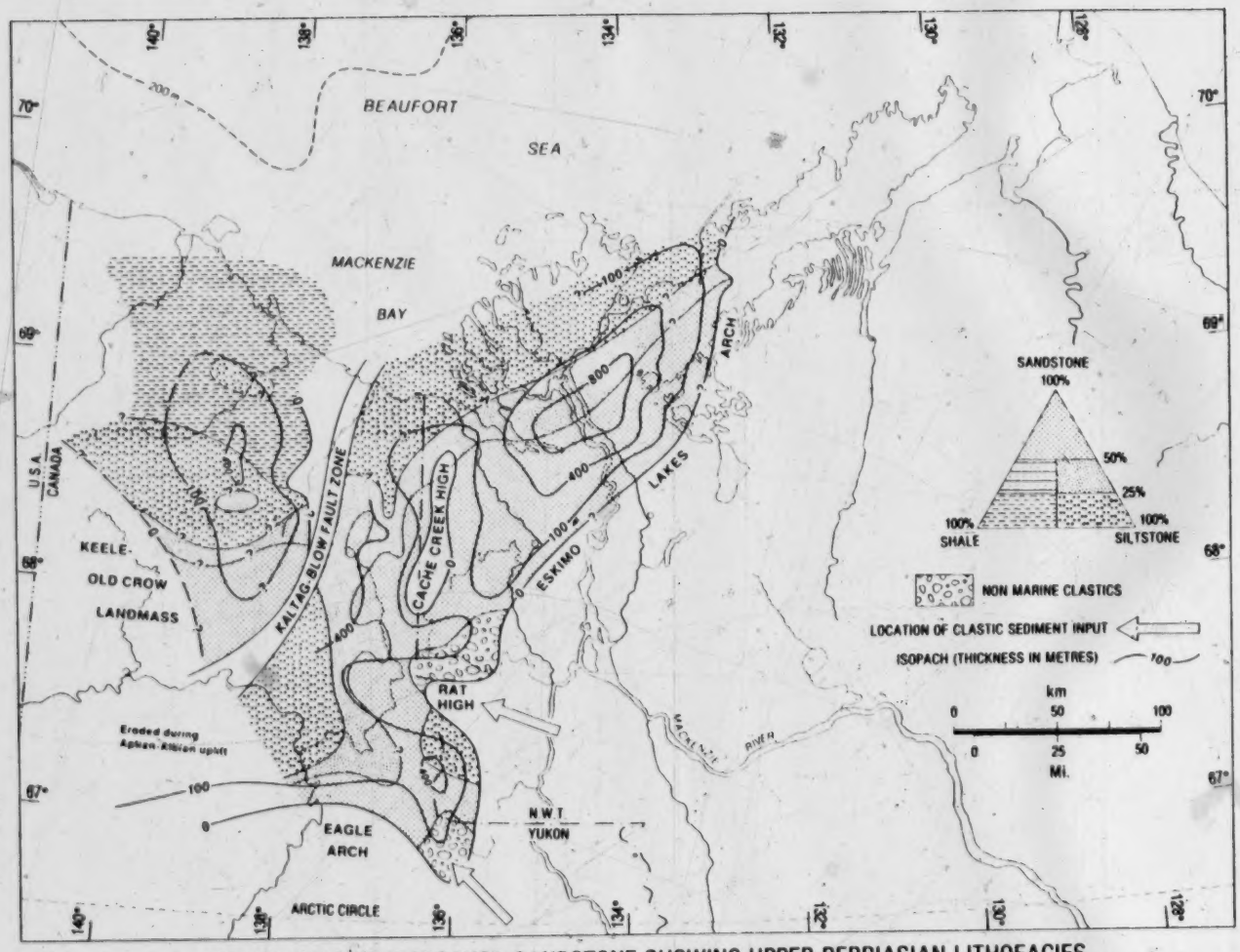


FIGURE 5 ISOPACH MAP OF "PARSONS" SANDSTONE SHOWING UPPER BERRIASIAN LITHOFACIES
(after Young et al., 1976)

Cache Creek High and Rat High created a nearshore environment where the high-energy, white sandstone member accumulated, perhaps until early Hauterivian time (Young et al., 1976, p. 19).

During early Hauterivian time, deltaic deposition shifted to the area of Aklavik and the Vittrekwa Embayment. Sedimentation in the Kugmallit Trough consisted of fine clastics while to the west, the coal-bearing division and equivalents were laid down. In the western portion of the basin, movement along the Kaltag-Blow Fault Zone caused uplift and subsequent regression, and a similar regressive phase occurred in the central and eastern parts of the basin. Late Hauterivian faulting in the area of the Cache Creek High and Rat High, and the Eskimo Lakes Arch resulted in uplift and erosion of much of the Neocomian sandstones.

Barremian time saw an extensive transgression blanket the entire region with a thick sequence of shales and siltstones. These deposits are informally called the upper shale-siltstone division (Jeletzky, 1958, p. 10).

With the approach of Aptian time, a regressive phase produced shallowing of the basin and depostion of an arenaceous unit, the upper sandstone division (Jeletzky, 1958, p. 10). This shallow-marine sandstone and siltstone sequence is recognised throughout the northern Richardson Mountains (Figure 6). It grades laterally northward and northeastward to shale (Young et al., 1976). The region experienced another episode of tectonism in early Aptian

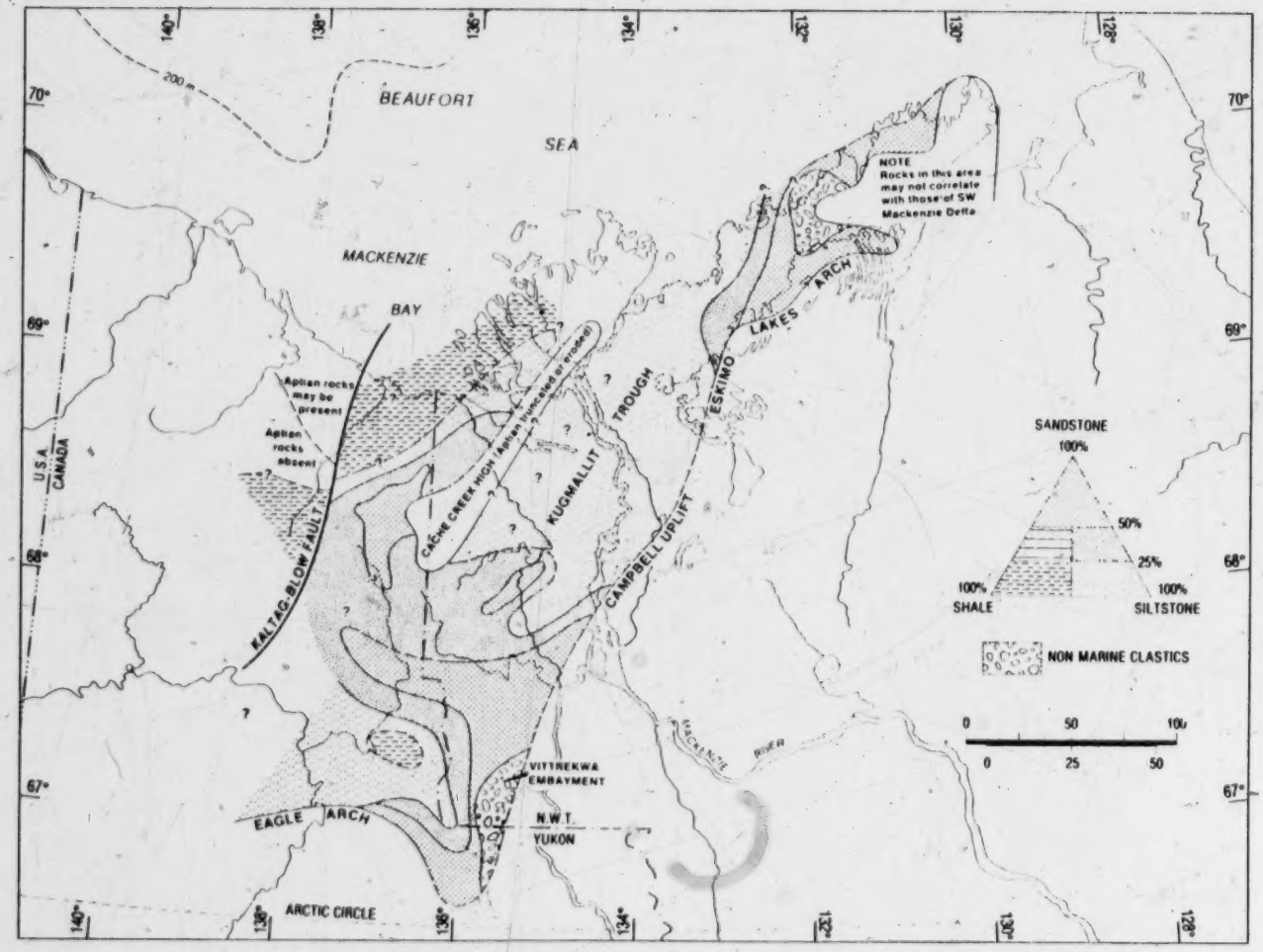


FIGURE 6

LITHOFACIES MAP OF EARLY APTIAN SEDIMENTS

(after Young et al., 1976)

time and renewed uplift of the Cache Creek High likely influenced regional depositional patterns during this time although erosion has obscured the relationship. Basin subsidence in late Aptian time resulted in widespread deposition of shales and siltstones of the upper member of the upper sandstone division and lower member of the Aptian-Albian flysch division. While deposition in the eastern portion of the Beaufort-MacKenzie Basin maintained its epicontinental character, the Blow Trough region underwent a flyschoid depositional phase (Young, 1978, p. 34). Transgression continued through to Albian time, resulting in extensive deposition of flyschoid rocks in the west and shales in the east (Figure 7).

Throughout Late Jurassic and Early Cretaceous time, the Kugmallit and Blow Troughs were the principal depocentres in the Beaufort-MacKenzie area as demonstrated by their thick accumulation of sediments. Figure 8, showing the preserved thickness of Barremian to Albian sediments illustrates the significance of these depocentres and of the other major tectonic elements on sedimentation in the region.

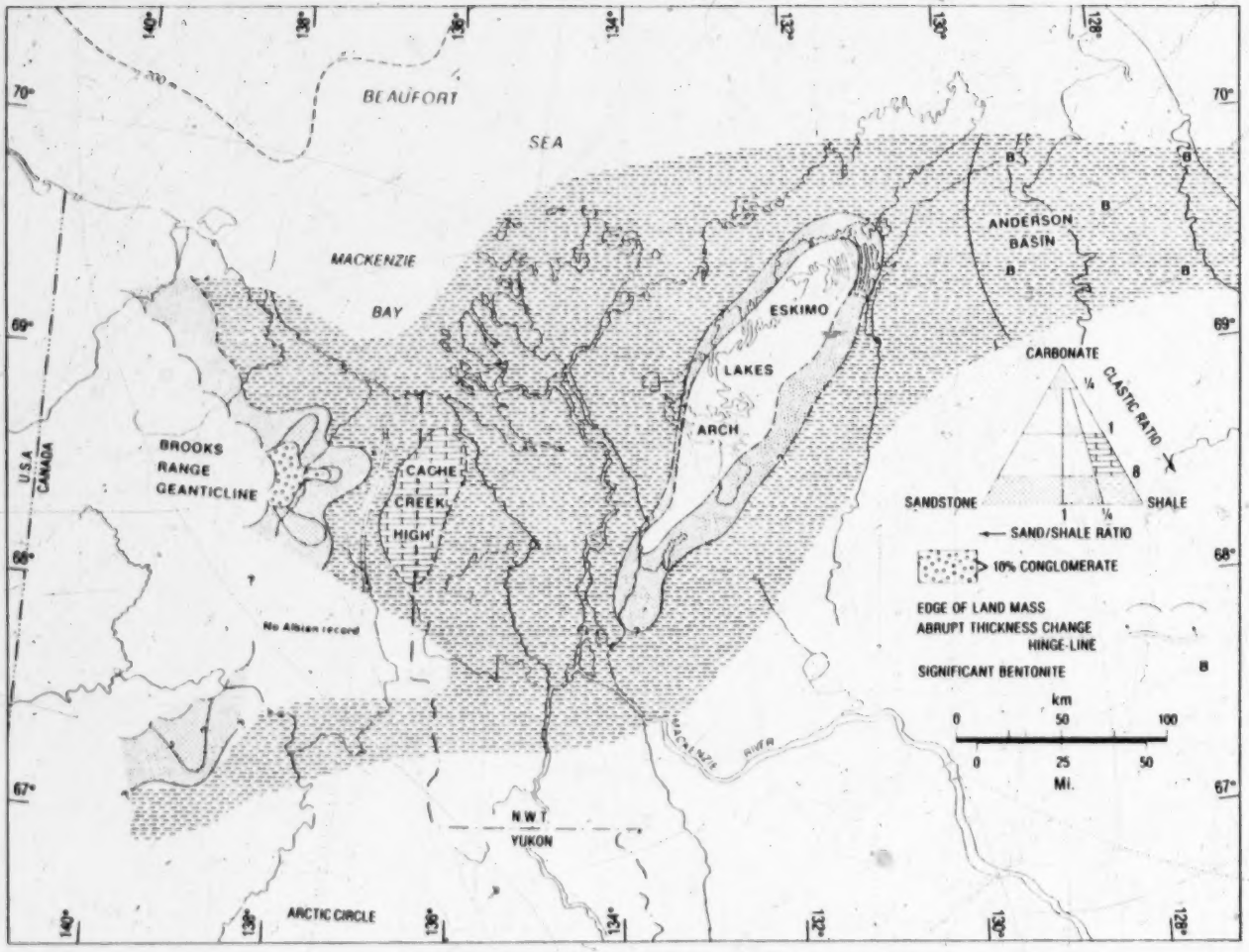


FIGURE 7 LITHOFACIES MAP OF EARLY ALBIAN SEDIMENTS

(after Young et al., 1976)

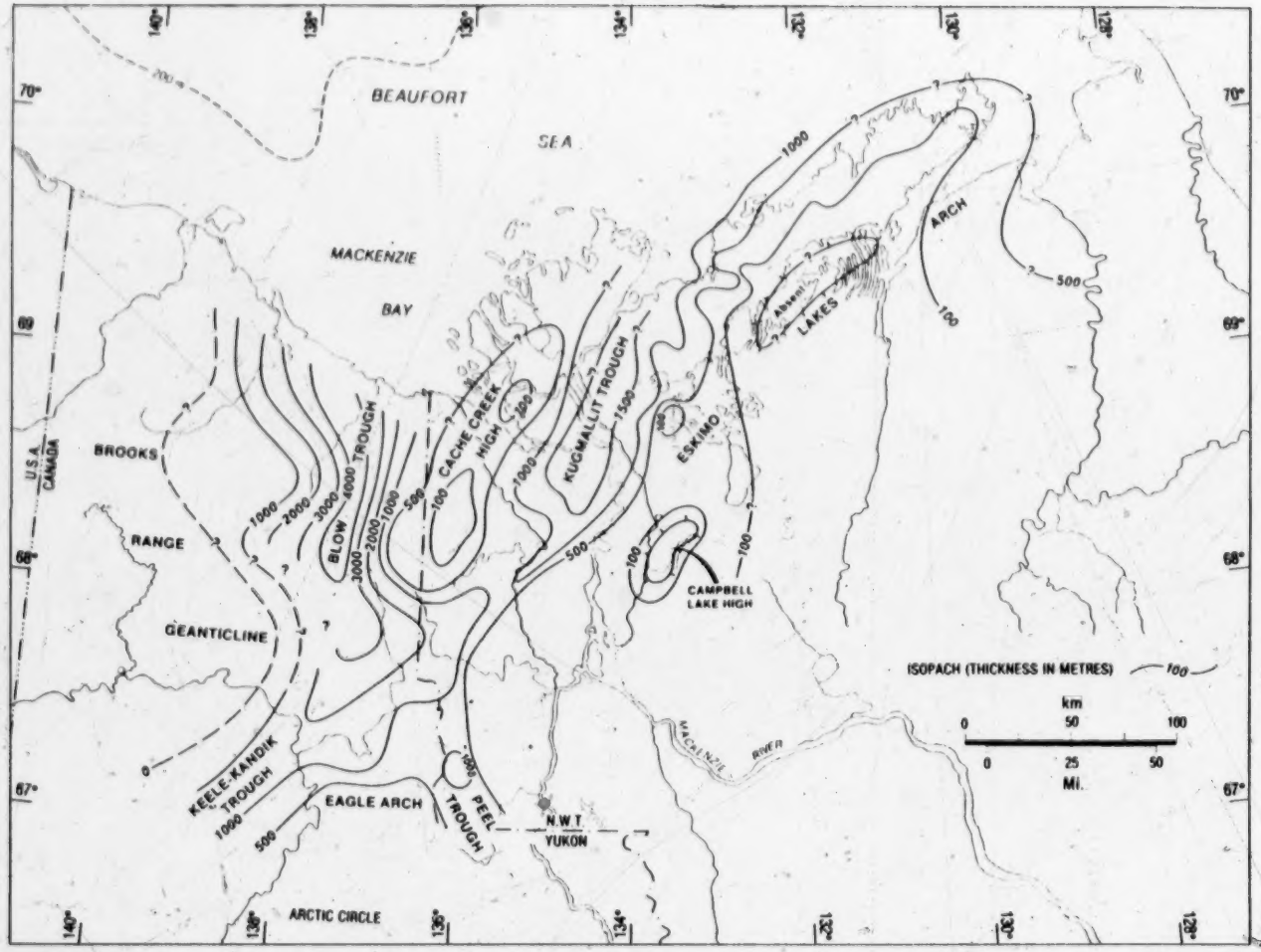


FIGURE 8 ISOPACH MAP OF PRESERVED BARREMIAN-ALBIAN SEDIMENTS

(after Young et al., 1976)

3. GEOLOGY ALONG CACHE CREEK

3.1 Description of Outcrops

Twenty-two outcrops were examined along Cache Creek (Figure 9). The following is a brief description of each outcrop, including its general lithology (and its quantitative composition if available) and its age as determined from paleontology. Also included is the formation or lithological division to which each outcrop belongs.

The outcrop descriptions are presented in the order of their occurrence, starting with RF 1 at the southern, upstream end of Cache Creek and proceeding downstream in a northerly direction to outcrop PS 7.

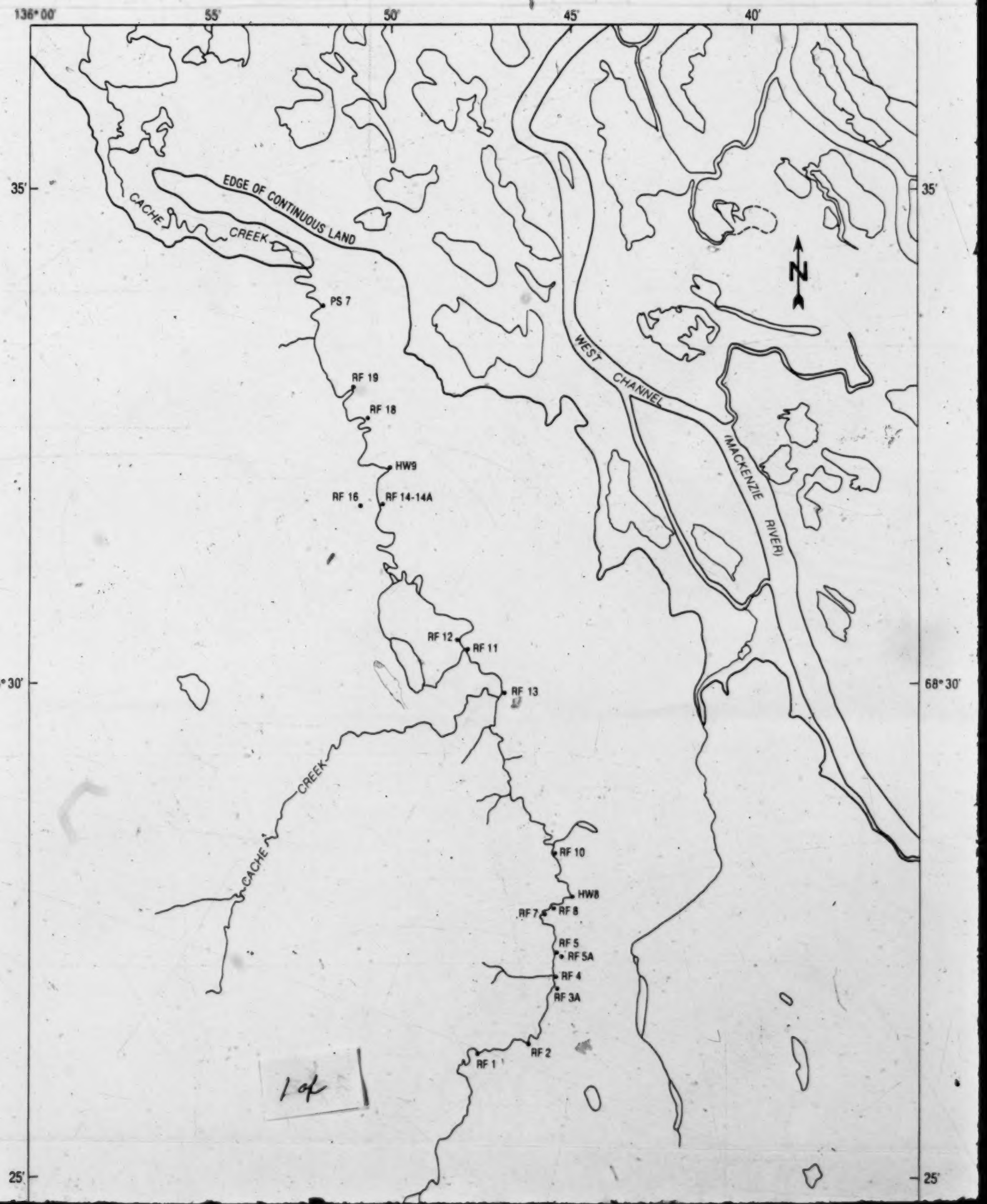
3.1.1 Outcrop RF 1

Outcrop RF 1 (Figure 9) is composed of olive grey silty shales containing occasional thin beds of grey-brown siltstone (Appendix 1). Numerous small clay ironstone concretions are present throughout the unit.

Age determinations from paleontology indicates a Barremian to early Aptian age for this outcrop (Figure 2). Outcrop RF 1 is considered to be from the lower member of the upper shale-siltstone division.

3.1.2 Outcrop RF 2

Outcrop RF 2 (Figure 9) consists of dark grey silty shale with several thin beds of brown siltstone (Appendix


136° 00'
55'
50'
45'
40'
35'
68° 30'
25'
EDGE OF CONTINUOUS LAND
CACHE CREEK
PS 7
RF 19
RF 18
HW9
RF 16
RF 14-14A
RF 12
RF 11
RF 13
CACHE CREEK
RF 10
HW8
RF 7
RF 8
RF 5
RF 5A
RF 4
RF 3A
RF 2
RF 1
WEST CHANNEL
(MACKENZIE RIVER)
N

1 of 1

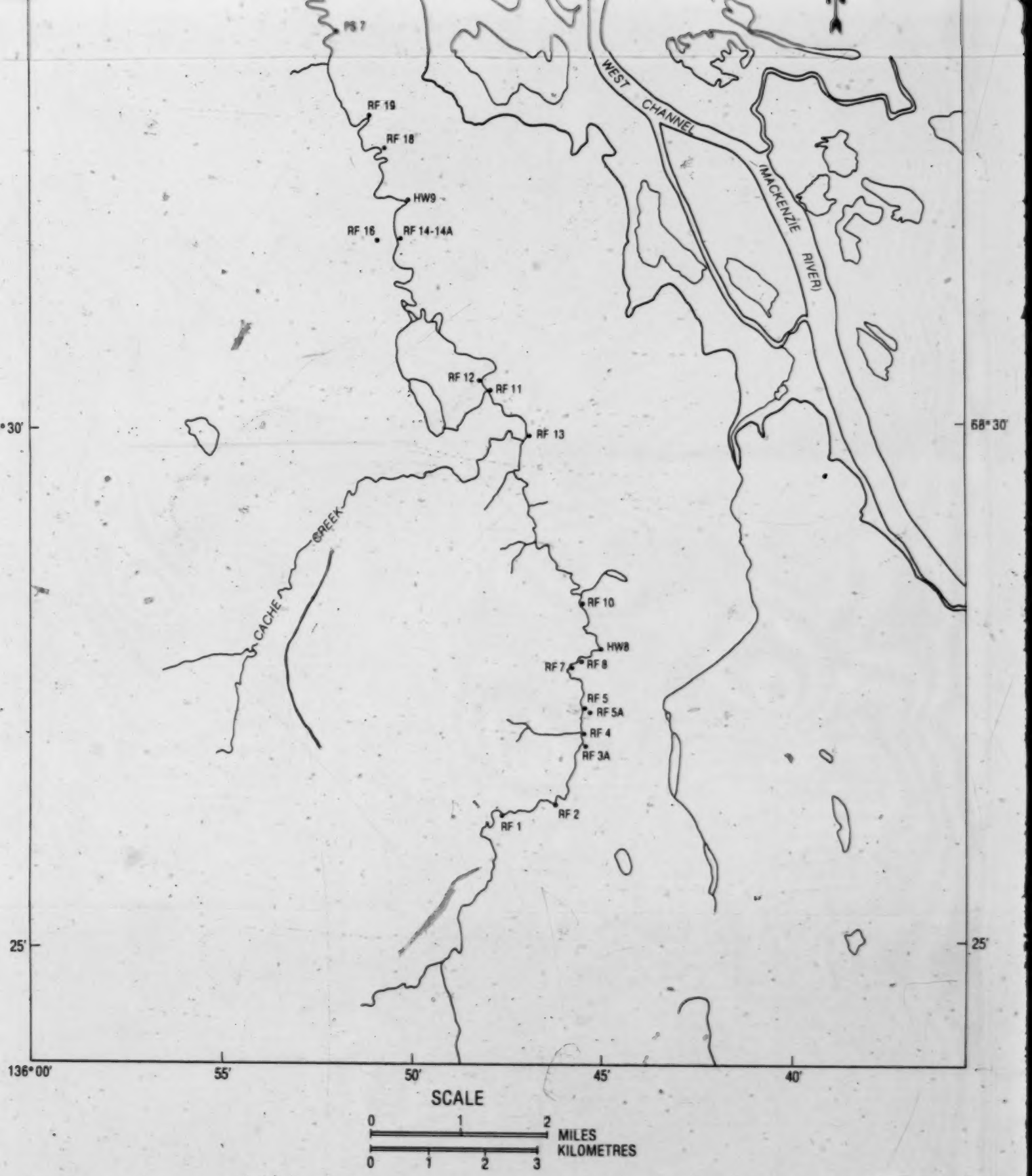


FIGURE 9. OUTCROP LOCATIONS

1). Clay ironstone concretions of variable size are common throughout the lower portion of the unit.

Paleontological data suggest a Barremian age (Figure 2) for this outcrop. Its lithology corresponds to that of the upper shale-siltstone division (Jeletzky 1958, p. 10), likely from the lower member of this division, and its Barremian age agrees with this assignment.

3.1.3 Outcrop RF 3A

Outcrop RF 3A (Figure 9) is a very poor exposure of dark grey silty shale (Appendix 1). The outcrop is considered to be of early Hauterivian to early Barremian age (Figure 2), and is thought to be from the lower member of the upper shale-siltstone division.

3.1.4 Outcrop RF 4

Outcrop RF 4 (Figure 9) is composed of yellowish brown, fine to very fine grained sandstone (Appendix 1). The sandstone composition is predominantly a sublitharenite (Appendix 2). Silica in the form of quartz overgrowth cement is the principal cement.

The outcrop is considered to be of late Berriasian to early Valanginian age (Figure 2). Its lithology and age indiciate Outcrop RF 4 to be from the lower sandstone division, probably from the buff sandstone member of this division (Jeletzky, 1977, op. cit., in Appendix 3).

3.1.5 Outcrop RF 5

Outcrop RF 5 (Figure 9) is composed of yellowish brown silty sandstone (Appendix 1). The unit is flaggy in part and massive otherwise. This fine to very fine grained sandstone is predominantly a subarkose (Appendix 2). Silica, in the form of quartz overgrowth cement and calcite cement are common.

No age determination was available for this outcrop, consequently positive assignment to a formation or lithological division is not possible. However, based on its lithology, the writer thinks that RF 5 is from the buff sandstone member of the lower sandstone division.

3.1.6 Outcrop RF 5A

Outcrop RF 5A (Figure 9) is predominantly a siltstone unit with several interbeds of sandstone (Appendix 1). The siltstone, olive grey in colour, is micaceous and glauconitic. The sandstone is a yellowish brown very fine grained subarkose bound by quartz overgrowth cement (Appendix 2).

This outcrop is of Barremian age (Figure 2), and with consideration of its lithology, it is likely part of the lower member of the upper shale-siltstone division.

3.1.7 Outcrop RF 7

Outcrop RF 7 (Figure 9) consists of an interbedded siltstone and sandstone sequence (Appendix 1). The siltstone

is olive-grey in colour and is slightly carbonaceous; the sandstone is yellowish brown in colour, very fine grained and is considered to belong to the subarkose clan (Appendix 2) with quartz overgrowths as the principal cement.

The outcrop is of Berriasian to Valanginian age (Figure 2). From its age and lithology, outcrop RF 7 is considered to be from the buff member of the lower sandstone division.

3.1.8 Outcrop RF 8

Outcrop RF 8 (Figure 9) is composed of an interbedded sandstone/siltstone sequence which grades upwards into a concretion-bearing massive silty sandstone unit (Appendix 1). The lower interbedded seqence is red in colour, due to its ferruginous nature, while the upper silty sandstone is yellowish brown. Large concretions are present in the lower portion of the upper member. The sandstone is subarkosic (Appendix 2), with silica (in the form of quartz overgrowths) constituting the principal cement.

Outcrop RF 8 is late Berriasian to early Valanginian in age (Figure 2) and is considered to be part of the buff member of the lower sandstone division.

3.1.9 Outcrop HW 8

Outcrop HW 8 (Figure 9) is composed primarily of olive grey shaly to sandy siltstones (Appendix 1). The lower portion of the outcrop contains several thin bands of ironstone concretions, while the upper siltstone contains

numerous small sideritic concretions. Some of these latter concretions contain pelecypod fossils.

The outcrop is of early Kimmeridgian to Berriasian age (Figure 2). Its lithology and age show it to be from the Husky Formation, likely from the lower member of this formation.

3.1.10 Outcrop RF 10

Outcrop RF 10 (Figure 9) is a predominantly grey sandstone section, fossiliferous in part, containing numerous beds of grey and ferruginous siltstone (Appendix 1). Principal cements of this subarkose are calcite, and silica (as quartz overgrowth).

Outcrop RF 10 is Kimmeridgian to Berriasian in age (Figure 2) and is considered to be part of the Husky Formation. Paleontological and lithological data suggest that this bed could be either a sandy unit within the lower member or part of the overlying arenaceous member of this formation. The arenaceous member is thought to shale out in the northern Richardson Mountains (Jeletzky 1967, p. 31) and therefore this unit is considered to be part of the lower Husky Formation, most likely from the lower member.

3.1.11 Outcrop RF 13

Outcrop RF 13 (Figure 9) is composed of yellowish brown sandstone and interbedded grey siltstone (Appendix 1), becoming increasingly arenaceous towards the top. Pelecypods

are present at several locations within the section. The sandstone is a sublitharenite (Appendix 2). Its principal cement is silica (as quartz overgrowths) but calcite cement is not uncommon.

This outcrop is late Berriasian to early Valanginian in age (Figure 2). Its age and lithology are characteristic of the buff member of the lower sandstone division (Jeletzky 1958, p. 7). The writer feels that RF 13 may represent the gradational zone between the lowest buff sandstone member and the underlying Husky Formation.

3.1.12 Outcrop RF 11

Outcrop RF 11 (Figure 9) is composed of light brown flaggy sandstone which becomes interbedded with numerous thin beds of grey siltstone towards the top of the unit (Appendix 1). Several coal pods are present in the mid portion of the outcrop. The sandstone, which is fine to very fine grained, is sublitharenitic in the lower 20 metres of the outcrop, and is subarkosic in the remaining 7 metres (Appendix 2). Silica, as quartz overgrowth, is the dominant cement in both sandstone types.

Age determination from paleontology places RF 11 at a late Berriasian to early Valanginian age (Figure 2). Based on its age and lithology, this outcrop is considered to be from the buff sandstone member of the lower sandstone division.

3.1.12 Outcrop RF 12

Outcrop RF 12 (Figure 9) is composed of light brown laminated sandstone (Appendix 1). Numerous pelecypod burrows are distributed throughout the unit. The fine grained sandstone is subarkosic (Appendix 2). Quartz overgrowth is the dominant cement; calcite cement is present in lesser abundance.

This outcrop yielded no fossils, consequently its age could not be determined. However, because its lithology is similar to that at RF 11, and because of its structural proximity to this outcrop, the writer feels that RF 12 is also part of the buff sandstone member of the lower sandstone division.

3.1.14 Outcrop RF 15

Outcrop RF 15 (Figure 9) is composed of a thick succession of grey silty shales (Appendix 1) with several thin beds of very fine grained calcareous silty sandstone.

Paleontological samples suggest an Hauterivian to Barremian age for this outcrop (Figure 2). Considering its age and lithology, RF 15 is thought to be from the lower member of the upper shale-siltstone division.

3.1.15 Outcrop RF 14-14A

Outcrop RF 14-14A (Figure 9) is composed of three discrete units of sandstone separated by covered intervals (Appendix 1). The sandstone is fine to very fine grained and

glauconitic, and is yellowish brown in colour. Pelecypods and pelycepod burrows are present throughout much of the section. Compositionally the sandstone is predominantly a quartzarenite (Appendix 2), with silica, in the form of quartz overgrowths, and calcite as the principal cements.

This outcrop is considered to be of late Hauterivian to Albian age. Its age, in conjunction with its lithology, indicate that outcrop RF 14-14A is likely to be from the lower member of the upper sandstone division.

3.1.16 Outcrop RF 16

Outcrop RF 16 is a poorly exposed section of pale orange, fine grained sandstone (Appendix 1) containing abundant pelecypods and pelecypod burrows. It composition is that of a quartzarenite (Appendix 2) with quartz overgrowths and calcite as the principal cements.

No paleontological information was available from this outcrop. However, as it lies along strike from RF 14-14A, which is an upper sandstone division outcrop, and is similar in lithology , the writer considers RF 16 to be from the lower member of the upper sandstone division.

3.1.17 Outcrop HW 9

Outcrop HW 9 (Figure 9) is composed of a thin unit of interbedded brown silty shales and grey sandstones which are overlain by a thicker unit of very fine grained to silty sandstone (Appendix 1). The sandstone belongs to the

subarkose clan (Appendix 2), and the lowest part of the unit contains numerous stellate nodules, commonly called hedgehog concretions (Kemper et al., 1975).

No age determination was available for this outcrop; however, since HW 9 is lithologically similar to RF 18 and RF 19, both of which are upper shale-siltstone division outcrops (to be described later), the writer believes that outcrop HW 9 may be from the upper member of the upper shale-siltstone division.

3.1.18 Outcrop RF 18

Outcrop RF 18 (Figure 9) is largely composed of grey shaly siltstone with thin bands and lenses of dark siltstone irregularly distributed throughout (Appendix 1). Ironstone concretions are common.

The outcrop provides fossils indicative of a late Barremian age (Figure 2), and based on this age and the general lithology, outcrop RF 18 is considered to be from the upper member of the upper shale-siltstone division.

3.1.19 Outcrop RF 19

Outcrop RF 19 (Figure 9) is composed of a thick sequence of grey concretionary silty sandstone which is overlain by a relatively thin bed of flaggy, fossiliferous sandstone (Appendix 1). The sandstone throughout the outcrop is a sublitharenite (Appendix 2) and is cemented principally by silica in the form of quartz overgrowths.

This outcrop is considered to be of late Barremian to Aptian age (Figure 2). Its age and lithology are characteristic of the upper member of the upper shale-siltstone division (Jeletzky 1958, p. 10) and according to Jeletzky(op. cit., 1977, in Appendix 3), likely it is from the uppermost 61 metres of this division.

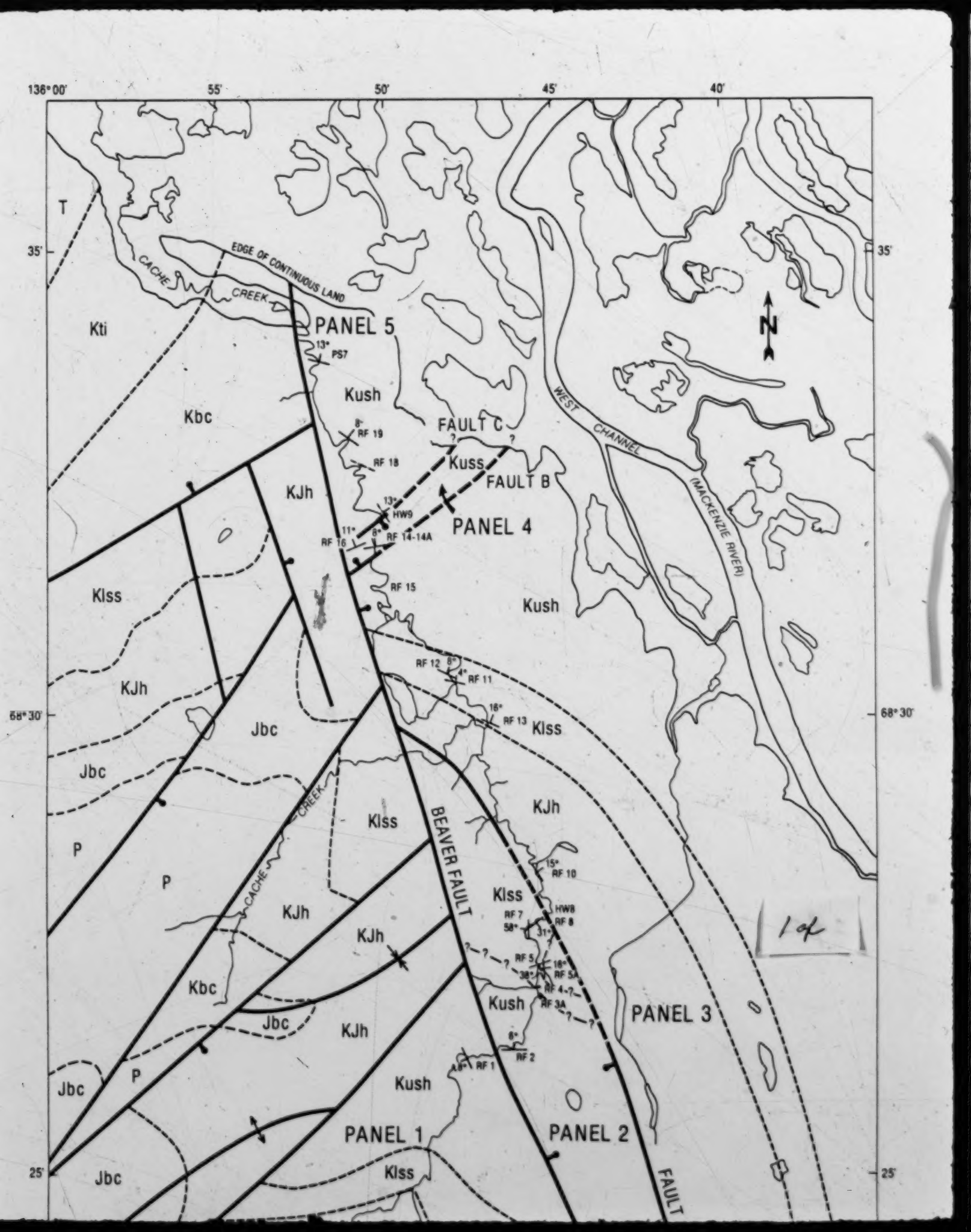
3.1.20 Outcrop PS 7

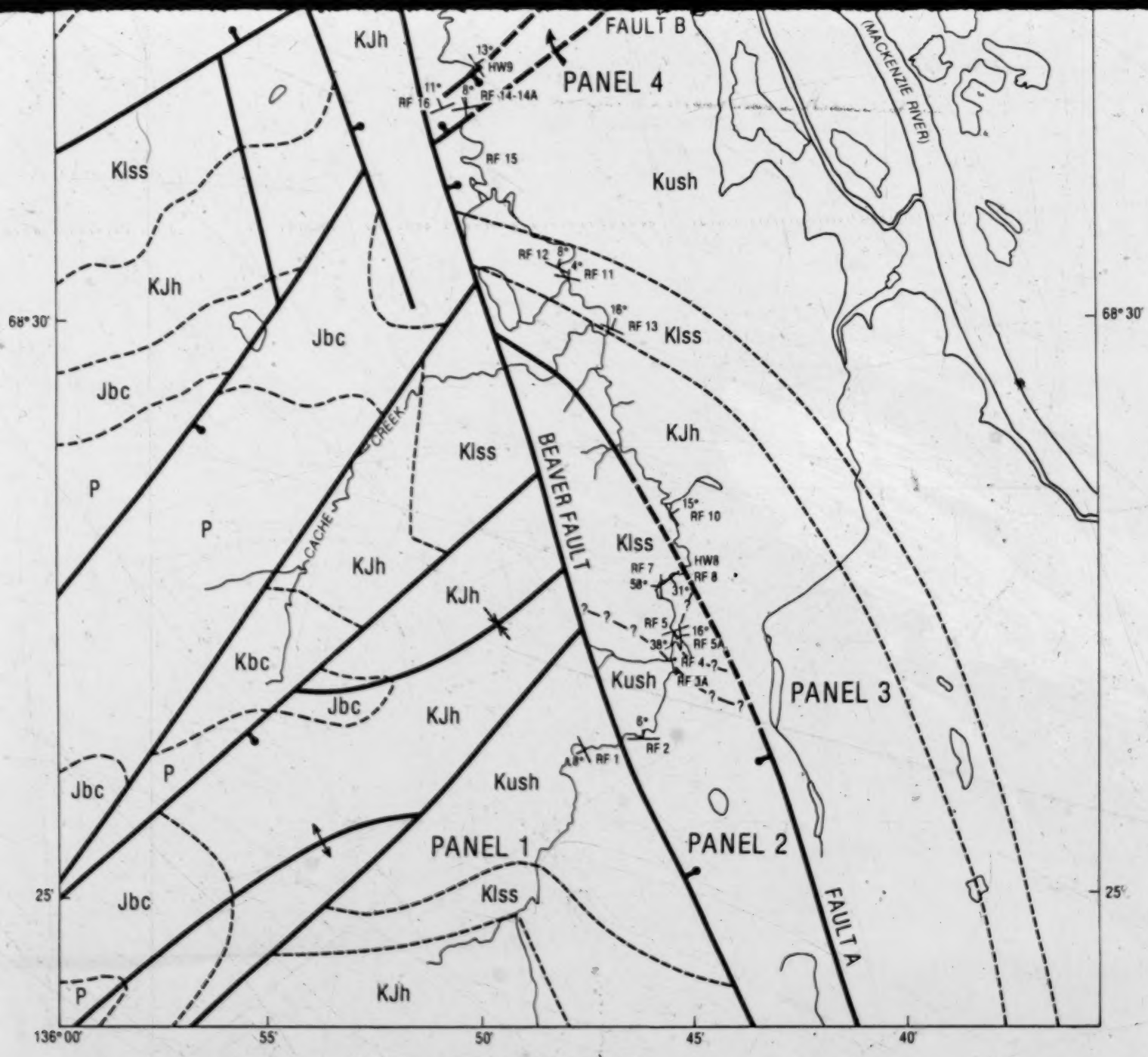
Outcrop PS 7 (Figure 9) is composed of brown flaggy sandstone with thin interbeds of dark siltstone and shale (Appendix 1). The lower portion of the section contains numerous vertical burrows and the middle and upper portions of the section contain stellate nodules (Kemper et al., 1975). The sandstone is considered to be sublitharenitic (Appendix 2) and cemented by silica, in the form of quartz overgrowths.

Outcrop PS 7 is of latest Barremian through Aptian age (Figure 2), corresponding to the uppermost upper shale-siltstone division or the upper sandstone division. Considering its general lithology, the writer feels that PS 7 is likely to be from the uppermost part of the upper shale-siltstone division.

3.2 LOCAL STRUCTURE

The structure of the Cache Creek area is shown in Figure 10. This map, originally compiled by Norris (1975), has been slightly modified by the writer to incorporate the


136° 00'
55'
50'
45'
40'
35'
68° 30'
25'
T
Kti
Kbc
Kuss
Kush
KJh
Klss
Jbc
P
EDGE OF CONTINUOUS LAND
CACHE CREEK
PANEL 5
PANEL 4
PANEL 3
PANEL 2
PANEL 1
FAULT C
FAULT B
BEAVER FAULT
WEST CHANNEL
(MACKENZIE RIVER)
N
13° PS7
8° RF 19
RF 18
13° HW9
11° RF 16
8° RF 14-14A
RF 15
RF 12
8° 4° RF 11
18° RF 13
15° RF 10
HW8
RF 7
58° 31° RF 8
RF 5
18° 38° RF 5A
RF 4
RF 3A
8° RF 2
RF 1
FAULT



STRATIGRAPHY

TERTIARY	T	JURASSIC	
CRETACEOUS		HUSKY Fm.	KJh
TENT ISLAND Fm.	Kti	BUG CREEK Fm.	Jbc
BOUNDARY CREEK Fm.	Kbc	PERMIAN	P
UPPER SANDSTONE DIV.	Kuss		
UPPER SHALE-SILTSTONE DIV.	Kush		
LOWER SANDSTONE DIV.	Kiss		

FAULT (DEFINITE)
FAULT (PROBABLE)
DOWNTHROWN BLOCK
LITHOLOGICAL BOUNDARY
ANTICLINE
SYNCLINE

SCALE
Mi. 0 1 2
km 0 1 2 3

FIGURE 10. CACHE CREEK STRUCTURE MAP

geology observed along Cache Creek.

The study area lies on the flank of the northeasterly plunging Cache Creek High (Norris, 1973), and straddles five elongated fault blocks, or panels, which are truncated by northerly trending high-angle faults (Figure 10).

The Beaver Fault (Norris, 1978, p. 13) is a northerly trending fault which truncates the southern portion of the study area. The panel to the east of the fault is downthrown relative to the west side of the fault. A second major fault crosses the southern portion of the area. This northerly trending fault, designated Fault A on Figure 10, approximately parallels the Beaver fault and towards the north abuts against it. While its trace is visible in the southern portion of the map area, its presence in the study area is inferred from the variance of adjacent bedding orientations. Two other faults, designated Fault B and Fault C, are located in the northern portion of the study area. Neither fault is visible in outcrop, but their presence are inferred from changes in bedding orientation in the adjacent panels, and from the stratigraphic relationships of beds in these panels.

Panel 4, separated from panels 3 and 5 by faults B and C consists of upper sandstone beds, while the adjacent panels are composed of older strata, from the upper shale-siltstone division. Panel 4 can be interpreted as a graben with the downthrown panel preserving younger upper sandstone division strata within an otherwise continuous

sequence of older rock. However, as the nature of the faults is not known, this interpretation is very speculative.

Bedding to the north of Fault A, in panels 3, 4, and 5 dips gently to the north-east (Figure 10). Though the orientation of beds in each of these panels differs substantially, internally the orientation appears fairly uniform. From south to north, throughout these panels, the strike rotates in a counter-clockwise direction, possibly a reflection of the plunging nature of the Cache Creek High. The trend is not evident in panels 1 and 2 where attitudes display no identifiable pattern.

Within the study area, the greatest extent of stratigraphically continuous section is located in panel 3, between fault A and fault B. The complexity of bedding in panel 2, bounded by the Beaver fault and fault A, renders those outcrops unusable for stratigraphic interpretation. Panel 1, has only one measured orientation and cannot be related to strata in the adjoining panels. The structural complexity and lack of distinctive marker beds makes correlation of outcrops between panels very difficult.

3.3 LOCAL STRATIGRAPHY

3.3.1 Husky Formation

Strata of the Husky Formation were identified at two locations in the study area, sections HW 8 and RF 10. Only the lower member of the formation was identified in outcrop. The arenaceous member, red-weathering shale member, and

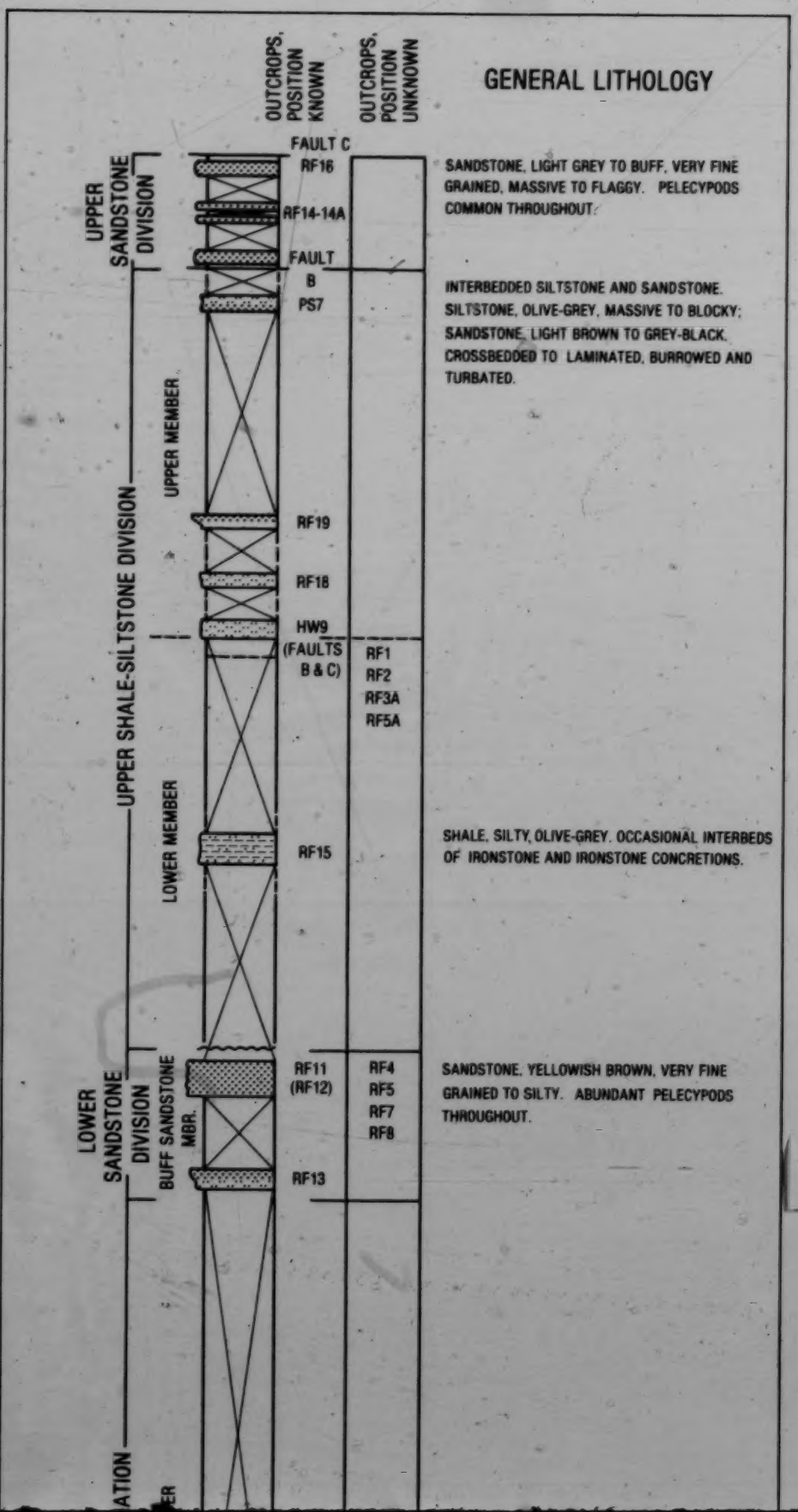
upper member were not observed.

The total Husky Formation present locally is shown in Figure 11. The formation is at least 470 metres thick, and likely exceeds 500 metres in thickness. This is thought to be an incomplete section as neither the basal nor upper contact was observed. The writer feels that the basal Husky Formation has been truncated by Fault A (Figure 10) immediately south of outcrop HW 8, and that the upper gradational contact lies at the base of outcrop RF 13.

Lithologically, the Husky strata examined in outcrop consist of dark shaly siltstones and very fine sandstones. The lowest portion of the lower member consists of olive-grey shaly to sandy siltstone. Bands of ironstone concretions are found in the lower beds, while small siderite concretions (occasionally fossiliferous) are common in the upper portion of the section. The more arenaceous component of the lower member is composed predominantly of pale olive to yellowish grey silty sandstone. These laminated to crossbedded rocks (Plate 1) contain occasional pelecypod fragments. Some of the beds are burrowed. Thin interbeds of grey-brown siltstone and of ironstone are common.

3.3.2 Lower Sandstone Division

Portions of the lower sandstone division were recognized at six locations in the study area. These sites, RF 4, RF 7, RF 8, RF 13, RF 11, and RF 12 are all identified


OUTCROPS, POSITION KNOWN
OUTCROPS, POSITION UNKNOWN
GENERAL LITHOLOGY
FAULT C
RF16
RF14-14A
FAULT B
PS7
RF19
RF18
HW9
(FAULTS B & C)
RF1
RF2
RF3A
RF5A
RF15
RF11 (RF12)
RF4
RF5
RF7
RF8
RF13
UPPER SANDSTONE DIVISION
UPPER SHALE-SILTSTONE DIVISION
UPPER MEMBER
LOWER MEMBER
LOWER SANDSTONE DIVISION
BUFF SANDSTONE MBR.
SANDSTONE, LIGHT GREY TO BUFF, VERY FINE GRAINED, MASSIVE TO FLAGGY. PELECYPODS COMMON THROUGHOUT.
INTERBEDDED SILTSTONE AND SANDSTONE. SILTSTONE, OLIVE-GREY, MASSIVE TO BLOCKY; SANDSTONE, LIGHT BROWN TO GREY-BLACK. CROSSBEDDED TO LAMINATED, BURROWED AND TURBATED.
SHALE, SILTY, OLIVE-GREY. OCCASIONAL INTERBEDS OF IRONSTONE AND IRONSTONE CONCRETIONS.
SANDSTONE, YELLOWISH BROWN, VERY FINE GRAINED TO SILTY. ABUNDANT PELECYPODS THROUGHOUT.

1 of

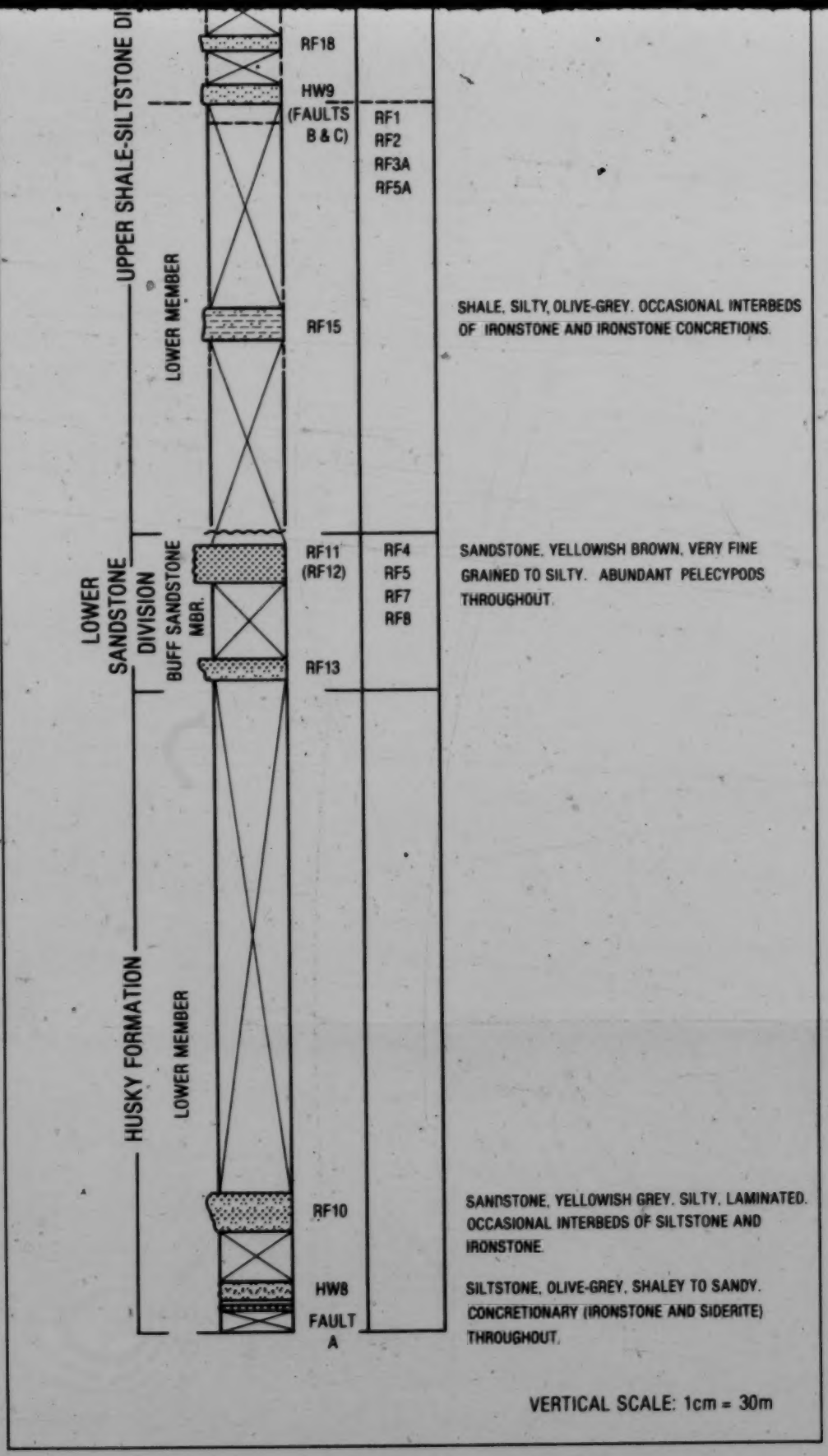


FIGURE 11. STRATIGRAPHIC COLUMN AT CACHE CREEK

Plate 1. Laminated and crossbedded sandstone in an arenaceous unit within the lower member Husky Formation at RF 10.

as from the buff sandstone member of this division. One other location, RF 5, may also be from some part of the lower sandstone division but no diagnostic biochronological data were obtained, nor was its structural orientation of assistance in placing it stratigraphically. Neither the white sandstone member nor any part of the overlying coal-bearing division was identified in outcrop.

The total Neocomian sandstone sequence present in the study area is shown in Figure 11. It consists only of a portion of the buff sandstone member of the lower sandstone division that is exposed at RF 13, RF 11 (Plate 2) and RF 12. Though no contacts were observed, it is interpreted that there may be about 130 metres present locally. Because of the local structural complexity, the other buff sandstone member outcrops, RF 4, RF 7 and RF 8 cannot be correlated or positioned stratigraphically.

The buff sandstone member of the lower sandstone division is locally characterized by very fine grained to silty yellowish brown sandstones that usually weather the same color. The sandstone beds are generally massive to flaggy but occasionally display well developed crossbedding. Pelecypods, occuring individually or as coquina hash are sparsely distributed throughout the unit. Pelecypod burrows are also common (Plate 3).

Compositionally, the buff sandstone member is diverse. The sandstones fall into three clans; sublitharenite is the most common, followed by subarkose, and quartzarenite

Plate 2. Lower sandstone division strata at RF 11.

Plate 3. Pelecypod burrows in lower sandstone division strata at RF 12.

(Appendix 2). Quartz overgrowth is the dominant cement of these sandstones. Lesser amounts of clay cements and rare carbonate cement are present. Porosity ranges from 0 to 18 percent.

3.3.3 Upper shale-siltstone division

The upper shale-siltstone division is interpreted to be present at nine locations in the study area. Sections RF 1, RF 2, RF 3A, RF 5A, RF 15, HW 9, RF 18, RF 19 and PS 7 are all considered to be part of this division.

The lower member of the upper shale-siltstone division is exposed at RF 1, RF 2, RF 3A and RF 15; upper member strata are present at HW 9, RF 18, RF 19 and PS 7.

No complete section of upper shale-siltstone division was located in the study area. Two separate sections, one consisting of the lower member of the division and the other composed of upper member strata are located in panels 3 and 5 respectively (Figure 10).

Only a partially exposed section of lower member lies between the lower sandstone division and the upper sandstone division (between panels 2 and 4, Figure 10). The lower contact with the lower sandstone division was not observed and its contact with the upper sandstone division is interpreted to be a fault contact. Assuming that the bedding orientation of the lower member is similar to that of the underlying lower sandstone division, a maximum of 255 metres of lower member could be present. Foreshortening of this

unit by faulting (Fault B, Figure 10) may be responsible for its limited exposure.

The upper member of the division, discontinuously exposed in panel 5 (Figure 10), may be in excess of 375 metres thick. The base of the member is truncated by Fault C and the top of it was not observed; it is thought to lie north of PS 7, which is considered to be part of the uppermost upper shale-siltstone division. The total thickness of upper-shale siltstone division may be at least 630 metres (Figure 11); however, because of the uncertain location of the contacts and the possible foreshortening of the mid portion of the division, this thickness is very approximate.

The dominant lithology of the lower member, upper shale-siltstone division in the area is olive grey silty shale containing occasional interbeds of ironstone and of ironstone concretions of variable size (Plates 4, 5). The observed upper member strata are composed of interbedded silty sandstones and siltstones. The sandstones are light brown to grey black in color and weather the same. Beds often display low angle crossbedding or thin laminations, and are occasionally burrowed and turbated. The siltstone is typically olive grey, massive to blocky in nature with no stratification evident. Irregular to spherical ferruginous concretions of variable size (2-8cm) are often present.

Stellate nodules (Kemper et al., 1975) are found in the siltstone at several locations. The nodules, also known as

Plate 4. Small ironstone concretions in the lower member of the upper shale-siltstone division at RF 1.

Plate 5. Large ironstone concretions in the lower member of the upper shale-siltstone division at RF 2.

hedgehog concretions, occur at HW 9 and PS 7. These oddities, as yet of uncertain significance, are thought to be the first identified in Cretaceous strata on mainland Canada. A brief discussion of these nodules is presented in Appendix 6.

3.3.4 Upper sandstone Division

Upper sandstone division exposure occurs at two localities in the study area, RF 14-14A and RF 16 in panel 4, Figure 10. These outcrops represent part of the lower portion of this division. At least 85 metres of upper sandstone strata are present in the study area (Figure 11). The local exposures represent only a portion of the lower member of the division, as the upper and lower contacts are not visible. The unit is thought to be fault bounded.

The upper sandstone strata consist of flaggy to massive, very fine grained, light grey to buff sandstone (Plate 6). Pelecypods occur individually throughout the unit, and in the lower portion they form a coquina hash. Indeterminant trumpet-shaped burrows (pelecypods?) are common (Plate 7). Compositionally, the sandstone belongs primarily to the quartzarenite clan (Appendix 2). Carbonate and silica, in the form of quartz overgrowth, are the principal cements and porosity varies from 0 to about 18 percent, apparently depending on the type and amount of cement present. The sandstones with carbonate cement are non-porous, while those with silica cement are very porous.

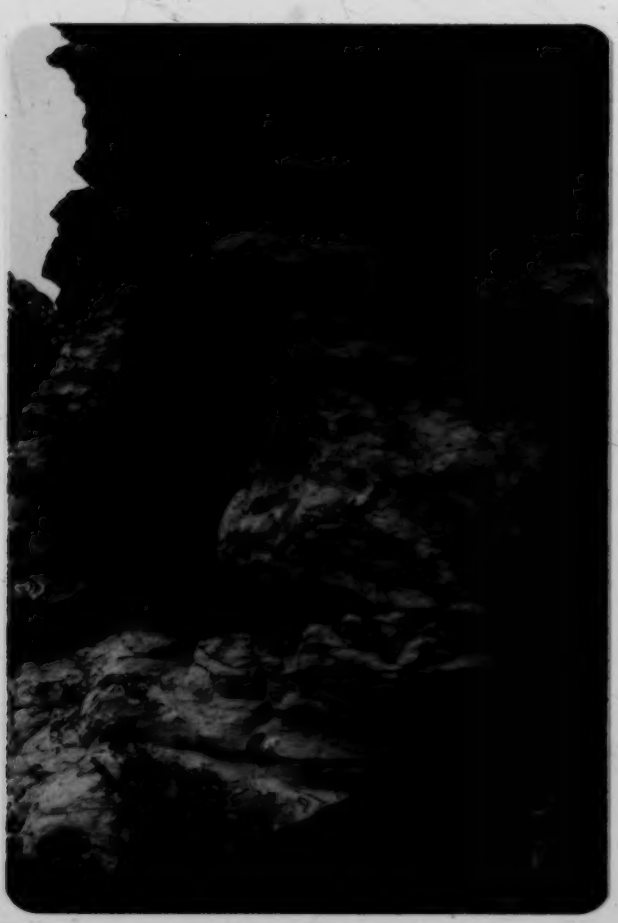


Plate 6. Massive to flaggy upper sandstone division strata at the base of RF 14-14A.

Plate 7. Trumpet-shaped pelecypod(?) burrows in upper sandstone division strata, 33 metres up section at RF 14-14A.

3.3.5 Local Stratigraphic Column

The complete stratigraphic sequence present in the study area is shown in Figure 11. The entire column of Upper Jurassic through Lower Cretaceous strata is about 1345 metres thick; however, the exposures examined represent only about 21% of the total projected column. Much of the remainder of the area is covered. Additional exposures of lower sandstone division and upper shale-siltstone division were measured, but these could not be related to the composite section because of their structural complications.

The Husky Formation is thought to be about 500 metres thick. Neither the base of the formation nor its upper contact was observed, consequently it may be even thicker. It is apparently overlain conformably by at least 130 metres of buff sandstone member of the lower sandstone division. This sandstone unit represents the entire Neocomian sandstone sequence present in the area. The white sandstone member and the overlying coal-bearing division are absent, either as a result of erosion or non-deposition.

Unconformably(?) overlying the buff sandstone member is an estimated 630 metres of upper shale-siltstone division. The upper and lower contacts were not observed, and some part of the middle portion of the unit may have been faulted out.

The youngest sediments present in the area constitute the upper sandstone division. About 85 metres of the arenaceous lower member is thought to overlie the upper

shale-siltstone division; the contact, though not visible in outcrop, is presumed to be a fault contact.

4. RELATIONSHIP OF CACHE CREEK AND MACKENZIE DELTA STRATA

4.1 Stratigraphy in Three Mackenzie Delta Wells

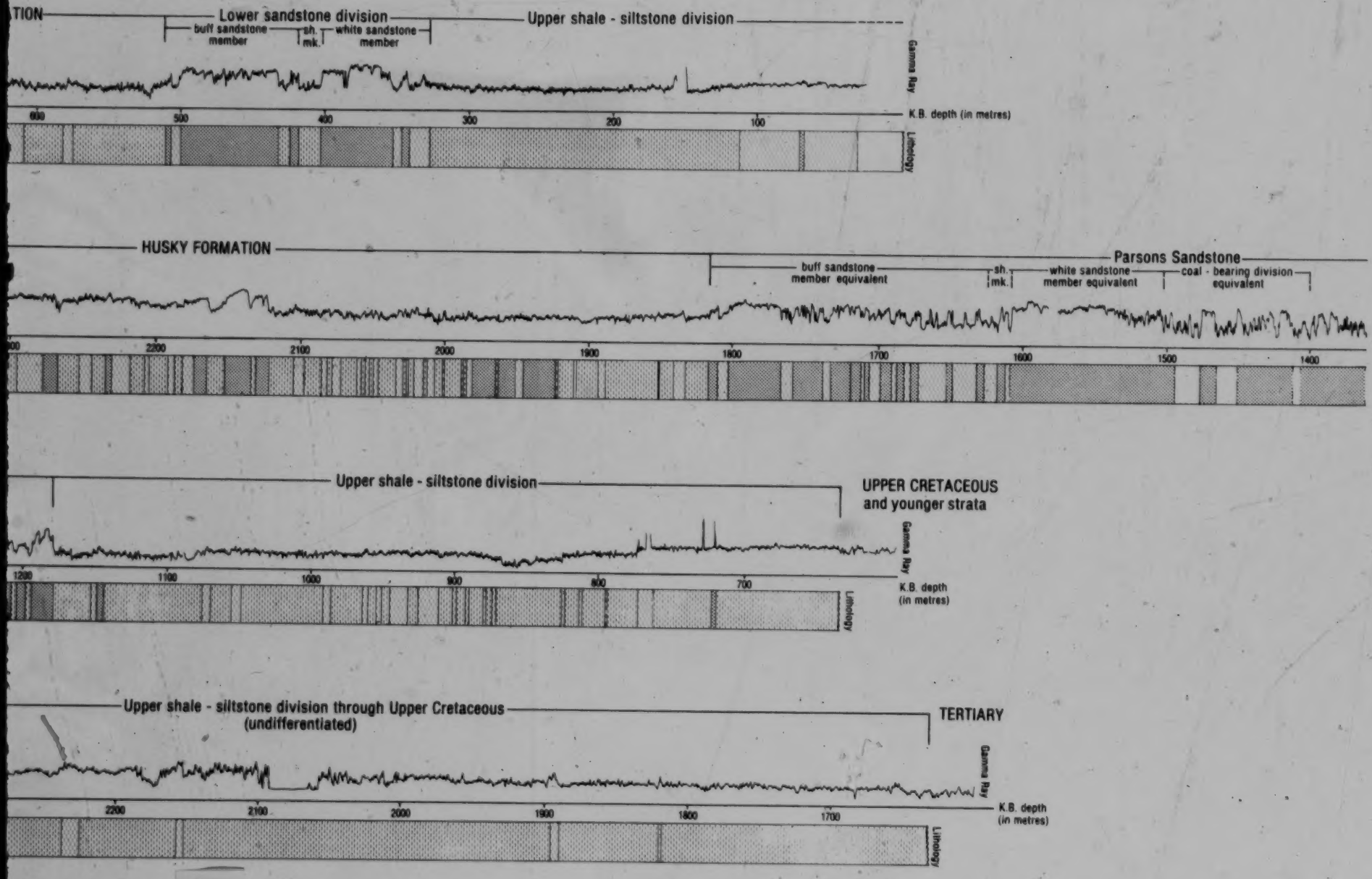
To relate the stratigraphy along Cache Creek to that beneath the the Mackenzie Delta, the equivalent geological column present in three exploratory wells (Shell Beaverhouse Creek H-13, Shell Unak B-11, and Shell Ulu A-35) (Figure 1) adjacent to the study area was examined.

A brief description of the relevant stratigraphic column present in each well is followed by comparison of the Formation/division thickness in the wells to that at Cache Creek. The significance of the variance in thickness will then be interpreted with respect to the general depositional setting.

4.1.1 Shell Beaverhouse Creek H-13

Shell Beaverhouse Creek H-13 is located approximately 15 kilometres southeast of the study area (Figure 1). Here the Upper Jurassic (Husky Formation) through Lower Cretaceous (upper sandstone division) sequence is about 775 metres thick (Figure 12), but does not represent a complete section. Erosion has removed all the overlying strata including some of the upper shale-siltstone division.

The Husky Formation comprises the basal 258 metres of the sequence. It is conformably overlain by about 187 metres of the lower portion of of the Parsons sandstone (equivalent to the lower sandstone division, Table 2). Its coaly


TION
Lower sandstone division
buff sandstone member
sh. mk.
white sandstone member
Upper shale - siltstone division
Gamma Ray
K.B. depth (in metres)
Lithology
HUSKY FORMATION
Parsons Sandstone
buff sandstone member equivalent
sh. mk.
white sandstone member equivalent
coal - bearing division equivalent
Upper shale - siltstone division
UPPER CRETACEOUS and younger strata
Upper shale - siltstone division through Upper Cretaceous (undifferentiated)
TERTIARY

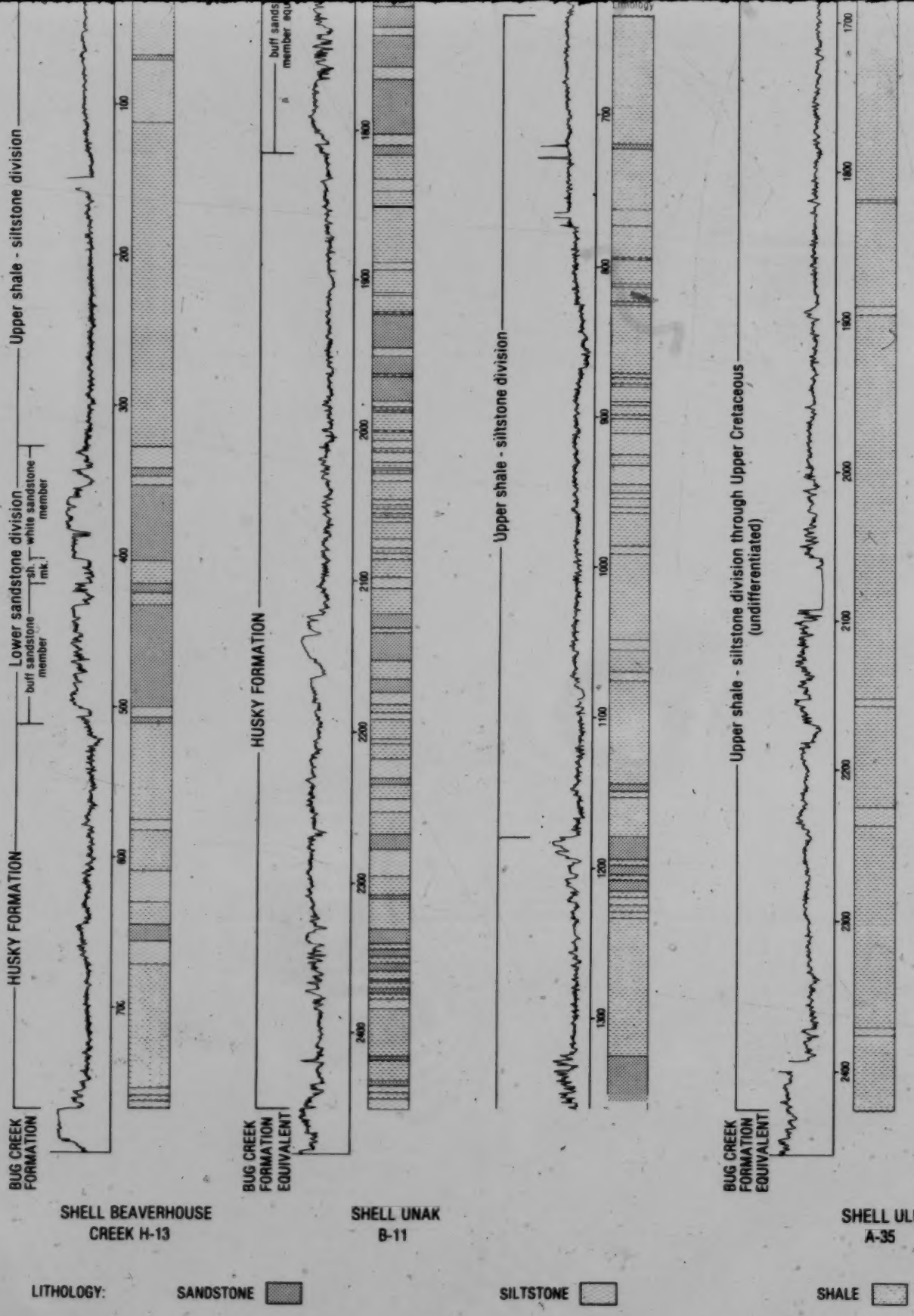


FIGURE 12. STRATIGRAPHY IN THREE ADJACENT WELLS

sandstone facies (equivalent to the coal-bearing division) is absent (Myhr et al., 1975, p. 255). The Parsons sandstone is in turn overlain (?)unconformably (Myhr et al ., 1975, p. 255) by the upper shale-siltstone division. This division, which is about 330 metres thick, crops out at the wellsite.

4.1.2 Shell Unak B-11

Shell Unak B-11 is located about 30 kilometres east of the study area (Figure 1). This well penetrates approximately 1809 metres of Upper Jurassic (Husky Formation) through Lower Cretaceous (upper sandstone division equivalent) strata (Figure 12).

As much as 619 metres of Husky Formation may be present. It is conformably overlain by about 641 metres of Parsons sandstone, consisting of 415 metres of lower sandstone division equivalent strata and 226 metres of coal-bearing division equivalent strata. The upper shale-siltstone division, which is about 549 metres thick, completes the sequence; its lower contact with the Parsons sandstone is thought to be conformable while the nature of the upper contact is unknown.

4.1.3 Shell Ulu A-35

Shell Ulu A-35 is located about 30 kilometres north of the study area (Figure 1). No estimate of the thickness of Upper Jurassic through Lower Cretaceous strata could be made here as the upper shale-siltstone division and Lower

Cretaceous strata, undifferentiated, rest unconformably on Middle Jurassic Bug Creek Formation (Figure 12). The Husky Formation and Parsons sandstone have been eroded.

4.2 Comparison and Interpretation of Strata Thickness

The entire Upper Jurassic (Husky Formation) through Lower Cretaceous (upper sandstone division) sequence along Cache Creek is about 1345 metres thick. This compares to 775 metres and 1809 metres respectively, of equivalent strata in Shell Beaverhouse Creek and Shell Unak.

The Husky Formation may be as much as 500 metres thick in the study area along Cache Creek. Shell Beaverhouse Creek contains approximately 258 metres of this formation (Figure 12), while Shell Unak has more than twice as much, about 619 metres (Figure 12). The thin development of the Husky Formation in Shell Beaverhouse Creek relative to that at Cache Creek and in Shell Unak suggests depositional thinning over the Cache Creek High. According to Figure 4, Shell Beaverhouse Creek would lie on the northern flank of the high, both the study area and Shell Unak would lie basinward of this well, and consequently thicker accumulations of sediment could be anticipated at both of the latter localities.

The lower sandstone division in the study area is about 130 metres thick. The equivalent Parsons sandstone (Table 2) is much thicker in Shell Beaverhouse Creek (187 metres) and in Shell Unak (641 metres) (Figure 11). Only the buff member

of the lower sandstone division is thought to be present along Cache Creek. In Shell Beaverhouse Creek, the complete lower sandstone division equivalent is present but the coal-bearing facies (equivalent to the coal-bearing division) is absent (Myhr et al., 1975, p. 255). The complete Parsons sandstone is present in Shell Unak.

Deposition of the Parsons sandstone (and equivalents) was likely continuous throughout the area. The great accumulation of section in Shell Unak could be due to its position deeper in the Kugmallit Trough, a major depocentre during Late Jurassic through Early Cretaceous time. By assuming an approximate geological setting as in Figure 5, the study area and Shell Beaverhouse Creek could be expected to receive less sediments because of their position on the Cache Creek High, and associated facies changes may contribute to the thin development of clastics at these sites (Myhr et al., 1975, p. 255). The thick clastic section in Shell Unak may grade laterally westward into the more argillaceous facies found in Shell Beaverhouse Creek.

Alternatively, the absence of the white sandstone member of the lower sandstone division and of the coal-bearing division in the study area and their equivalent units in Shell Beaverhouse Creek may simply be a result of pre-upper shale-siltstone erosion, an event that did not affect the sediments basinward, in Shell Unak. Based on the stratigraphy present at Cache Creek, no conclusion can be reached as to which of the two hypotheses is valid.

The upper shale-siltstone division is considered to be about 630 metres thick in the Cache Creek area. This compares to at least 549 metres of equivalent strata in Shell Unak. This division, which crops out at Shell Beaverhouse Creek, is at least 330 metres thick in that well. The upper shale-siltstone division could not be distinguished in Shell Ulu. Because of the uncertainty of the true depositional thickness of the division resulting from erosion or identification problems, no conclusions could be drawn regarding the depositional influences on its accumulation.

The thin unit of upper sandstone division strata observed in the study area is unique to the region. Equivalent strata are not present in the adjacent wells, nor in the surrounding area to the west. Though upper sandstone division deposition may have been widespread, as suggested by Lerand (1973, Figure 21) and by Young et al. (1976, p. 21), subsequent erosion has removed it. The upper sandstone division strata present locally are remnants of this deposition which was preserved by faulting, perhaps in a graben.

5. SUMMARY AND CONCLUSION

In the summer of 1977, the writer examined the geology along Cache Creek, Northwest Territories. The intention was to establish the local stratigraphic sequence based on outcrops and to relate the local sequence to the stratigraphy beneath the Mackenzie Delta.

Twenty-two outcrops were studied along Cache Creek. These were sampled for paleontology and lithology; paleontology (biochronology) is the principal tool through which the outcrops could be positioned stratigraphically. Strata ranging in age from Oxfordian (Late Jurassic) through Aptian (Early Cretaceous) were identified in the area. Their probable ages, in conjunction with their lithology, enabled the writer to assign each outcrop to an appropriate formation or division. In this manner, outcrops of Husky Formation (lower member), lower sandstone division (buff sandstone member), upper shale-siltstone divison, and upper sandstone division were identified. From the structural orientation of these outcrops, the complete stratigraphic succession of the study area was then generated.

The projected Husky Formation through upper sandstone division sequence in the study area is 1345 metres thick. The basal 500 metres is considered to be Husky Formation, but only the lower member of the formation, consisting of dark shale, siltstone and very fine sandstone, occurs in outcrop. This formation is overlain by 130 metres of buff

sandstone member of the lower sandstone division. This sandstone is predominantly a yellowish brown, fine grained sublitharenite. Neither the white sandstone member nor the coal-bearing division were observed locally. These latter units may be absent due to erosion prior to upper shale-siltstone division or because of facies change.

The upper shale-siltstone divison is at least 630 metres thick in the Cache Creek area, with the lower and upper members of this division identified in outcrop. The lower member is composed of dark grey siltstone with occasional beds of ironstone and ironstone concretions; the upper member is dominantly a brown sandstone-siltstone sequence.

The youngest strata identified along Cache Creek are from the upper sandstone division. About 85 metres of this Aptian age division is present, consisting mainly of yellowish brown, fine to very fine grained quartzarenite.

Although it is possible to postulate the occurrence of an almost complete section from Husky Formation through to upper sandstone division, little is actually exposed. About 80 percent of the suggested 1345 metres of section is covered and interpretation of the stratigraphic relationships of the outcrops has been complicated by faulting.

Comparison of the stratigraphic sequence in the Cache Creek area to that in several wells in the Mackenzie Delta showed a great variability in preserved thickness. Although

the writer was not able to establish whether these thickness variations were a result of depositional influences or a reflection of subsequent erosional events, or both, the dominance of the Cache Creek High on the local sedimentation is apparent throughout Late Jurassic to Early Cretaceous time in the Cache Creek area.

The geological study conducted by the writer in the Cache Creek area was successful in meeting its objectives. The stratigraphic units present in the study area were identified and their general lithology was described; the local stratigraphic sequence was established. The equivalent stratigraphic sequence was recognized in several wells in the Mackenzie Delta and an attempt was made to relate the observed variance in preserved thickness to local depositional factors.

While the observations and interpretations are considered valid, based on available data, extensive field work could result in identification of more sections, and finer delineation of the position and nature of lithological boundaries.

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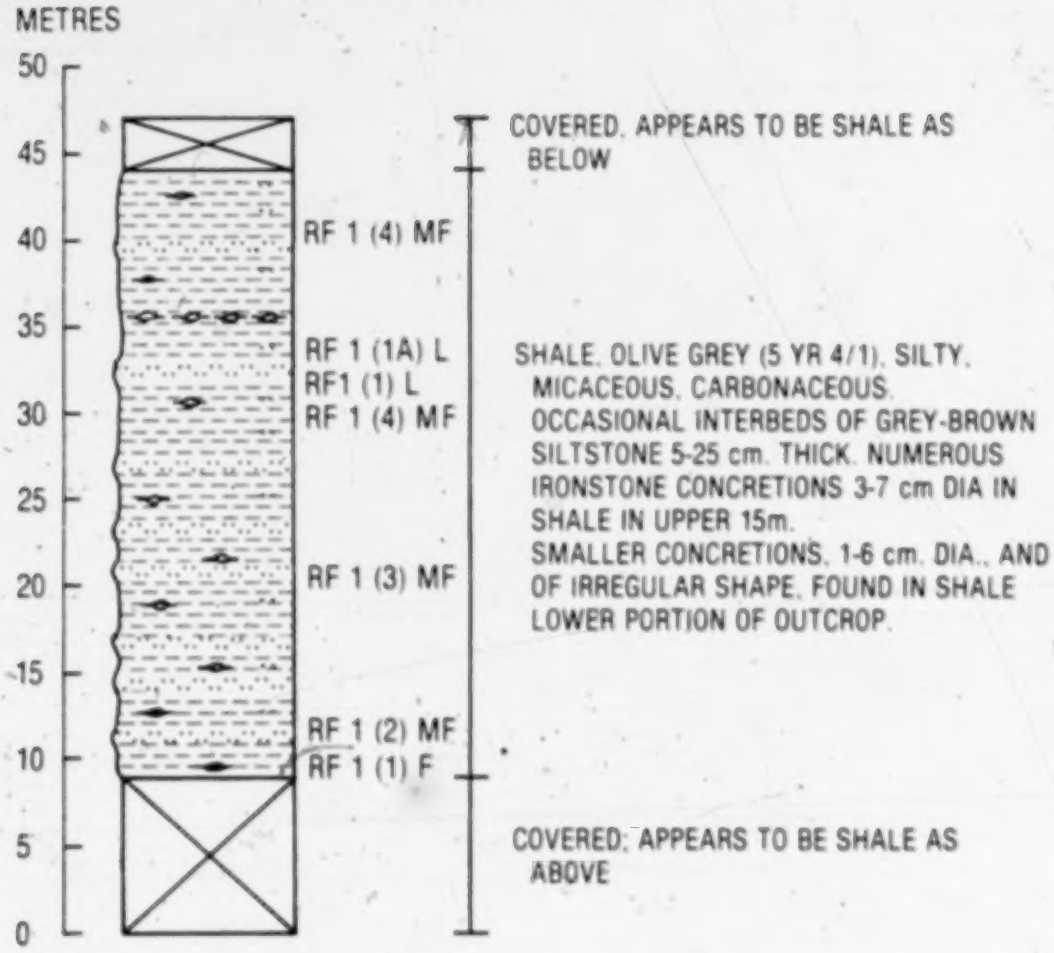
APPENDIX 1. Measured Sections

OUTCROP 77 RF 1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30
25
20
15
10
5
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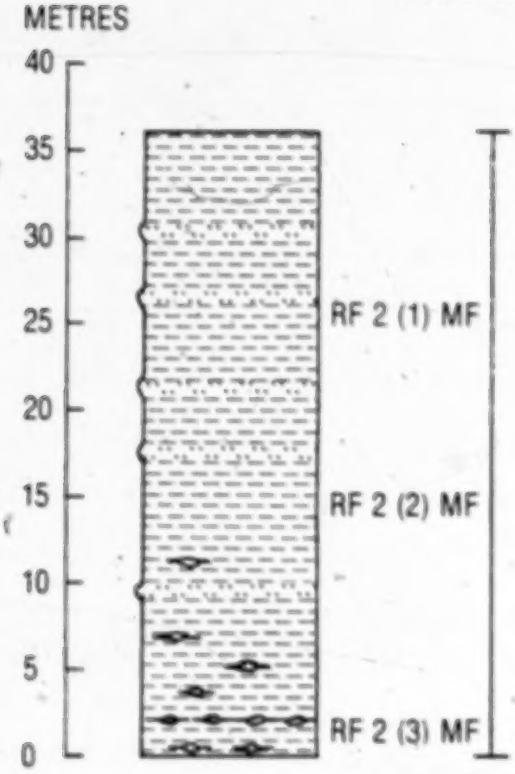
RF 1 (4) MF
RF 1 (1A) L
RF1 (1) L
RF 1 (4) MF
RF 1 (3) MF
RF 1 (2) MF
RF 1 (1) F
COVERED. APPEARS TO BE SHALE AS BELOW
SHALE. OLIVE GREY (5 YR 4/1). SILTY. MICACEOUS. CARBONACEOUS. OCCASIONAL INTERBEDS OF GREY-BROWN SILTSTONE 5-25 cm. THICK. NUMEROUS IRONSTONE CONCRETIONS 3-7 cm DIA IN SHALE IN UPPER 15m. SMALLER CONCRETIONS. 1-6 cm. DIA., AND OF IRREGULAR SHAPE. FOUND IN SHALE LOWER PORTION OF OUTCROP.
COVERED. APPEARS TO BE SHALE AS ABOVE

OUTCROP 77 RF 2

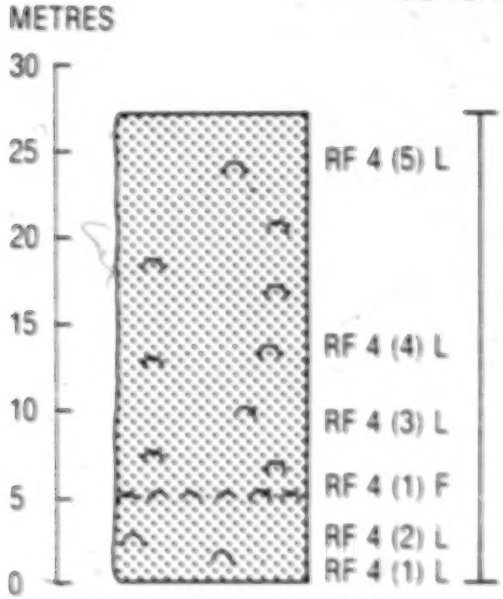


SHALE, DARK GREY (N3), SILTY, MICACEOUS. OCCASIONAL BANDS OF GREY-BROWN SILTSTONE, 20-25 cm. THICK. IRONSTONE CONCRETIONS PRESENT THROUGHOUT LOWER SECTION, 2-30 cm. DIA. SPHERICAL TO IRREGULAR IN SHAPE

OUTCROP 77 RF 3A

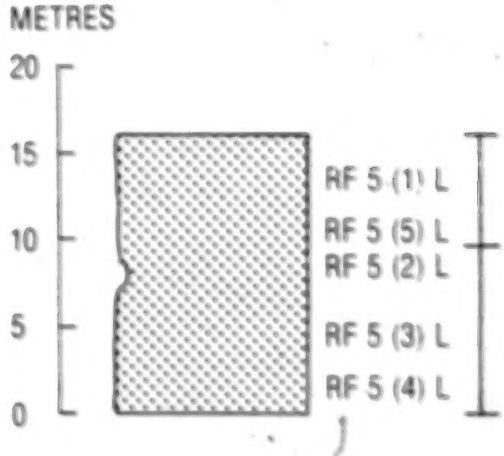
NO MEASURED SECTION DUE TO EXTENSIVE COVER.
SAMPLE RF 3A (1) MF TAKEN FROM BENEATH COVER.

OUTCROP 77 RF 4



SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/2). VERY FINE GRAINED, FERRUGINOUS. FINE LAMINATED IN LOWER 5m. AND UPPER 12m. MASSIVE IN MID-PORTION. FOSSILIFEROUS THROUGHOUT (BUCHIA). PROMINENT BAND OF PELECYPODS AT 5m.

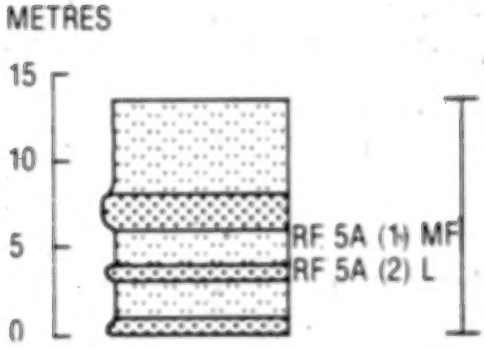
OUTCROP 77 RF 5



SANDSTONE. PALE YELLOWISH BROWN (10 YR 6/2) VERY FINE GRAINED TO SILTY. FLAGGY TO LAMINATED.

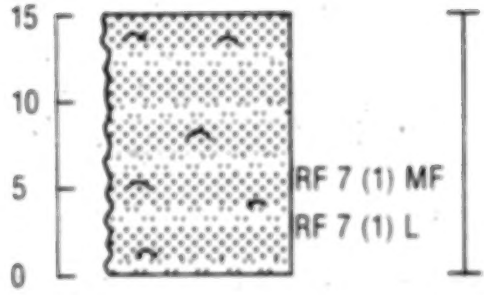
SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/2) VERY FINE GRAINED, MASSIVE. POORLY CEMENTED (RECESSIVE) SANDSTONE AT 8m. SANDSTONE IS CALCAREOUS IN LOWER 5m.

OUTCROP 77 RF 5A



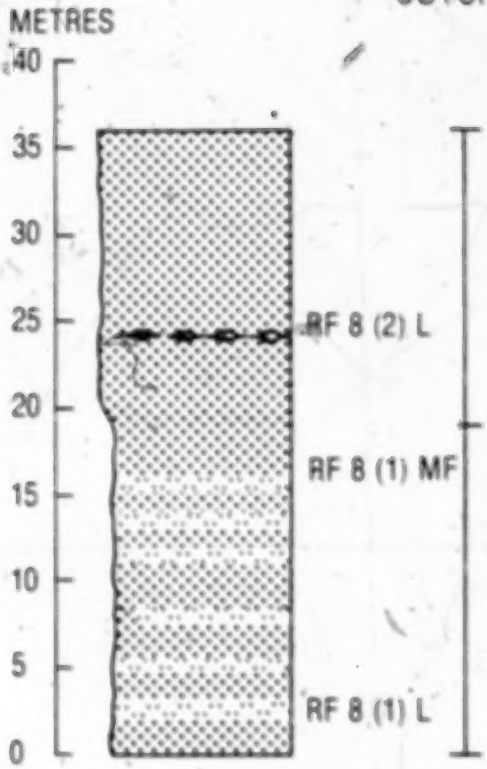
SILTSTONE. OLIVE GREY (5 YR 6/1). SANDY MICACEOUS. GLAUCONITIC. NUMEROUS SMALL (3 x 6 cm OR SMALLER) PODS OF SILTSTONE/SANDSTONE. SOME FOSSILFEROUS (BUCHIA). THREE DISTINCT BEDS OF SANDSTONE. PALE YELLOW BROWN (10 YR 6/2) VERY FINE GRAINED TO SILTY.

OUTCROP 77 RF 7



INTERBEDDED SANDSTONE AND SILTSTONE. SANDSTONE. PALE YELLOW BROWN (10 YR 6/2). VERY FINE GRAIN TO SILTY. LAMINATED. TURBATED. IRON STAINED. OCCASIONAL SHELL FRAGMENTS. SILTSTONE. GREY-BROWN. MICACEOUS BEDS 2-4 cm. THICK.

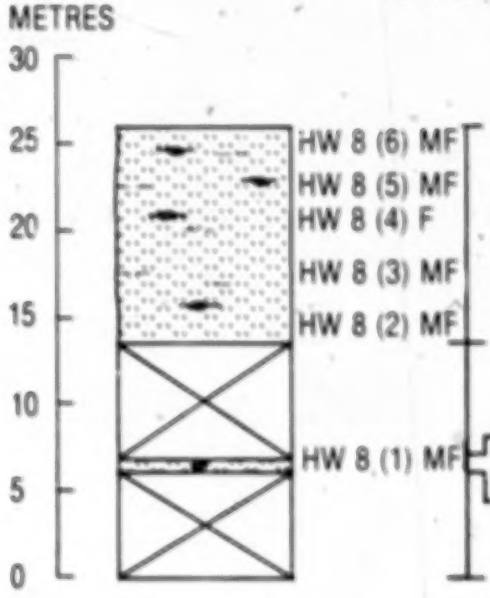
OUTCROP 77 RF 8



SANDSTONE. PALE YELLOW BROWN (10 YR 6/2). VERY FINE GRAINED TO SILTY MASSIVE TO FLAGGY. DISTINCT BAND OF IRONSTONE CONCRETIONS. 12-25 cm. DIA. AT 24 m.

INTERBEDDED SANDSTONE AND SILTSTONE SANDSTONE. PALE YELLOW BROWN (10 YR 6/2). VERY FINE GRAINED TO SILTY. FERRUGINOUS. LAMINATED. OCCASIONAL BURROWS. SILTSTONE. GREY-BROWN. MICACEOUS.

OUTCROP 77 HW 8



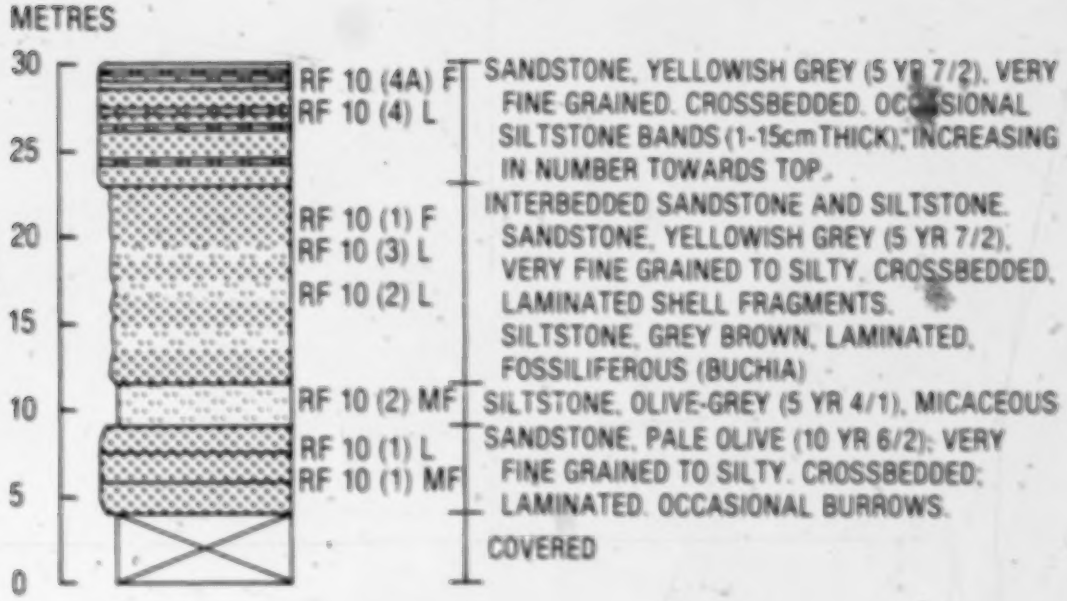
SILTSTONE. OLIVE GREY (5 YR 4/1). SHALY TO SANDY. MICACEOUS. CARBONACEOUS. SMALL SIDERITE CONCRETIONS. SOME FOSSILIFEROUS (PELECYPODS). ARE COMMON.

COVERED

SILTSTONE. OLIVE GREY (5 YR 4/1). CONCRETIONARY.

COVERED

OUTCROP 77 RF 10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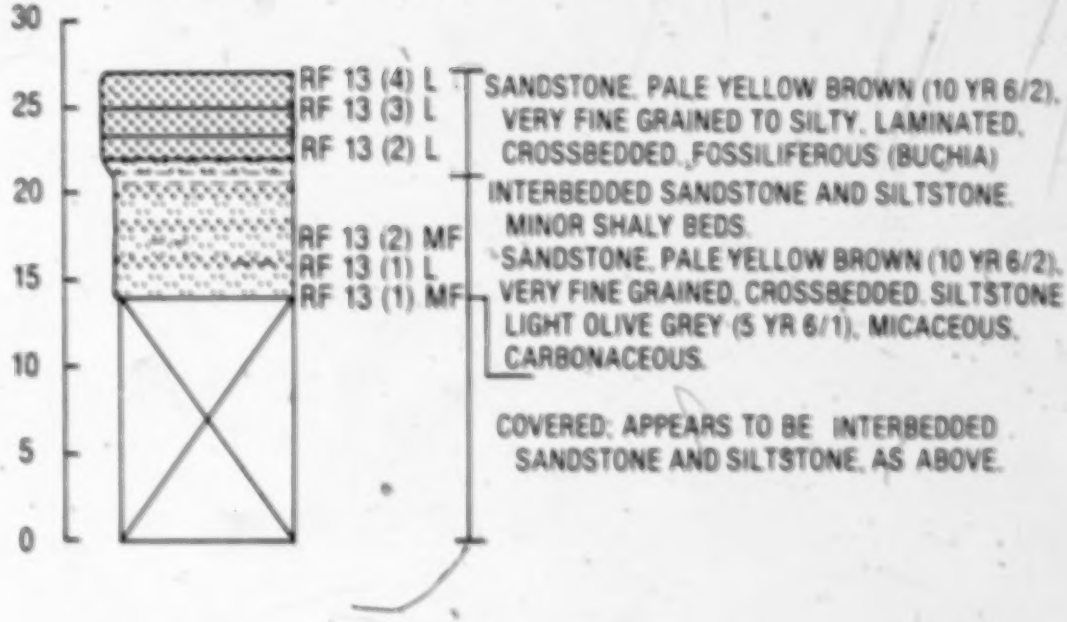
RF 10 (1) F
RF 10 (3) L
RF 10 (2) L
RF 10 (2) MF
RF 10 (1) L
RF 10 (1) MF
SANDSTONE. YELLOWISH GREY (5 YR 7/2). VERY FINE GRAINED. CROSSBEDDED. OCCASIONAL SILTSTONE BANDS (1-15cm THICK). INCREASING IN NUMBER TOWARDS TOP.
INTERBEDDED SANDSTONE AND SILTSTONE.
SANDSTONE. YELLOWISH GREY (5 YR 7/2). VERY FINE GRAINED TO SILTY. CROSSBEDDED. LAMINATED SHELL FRAGMENTS.
SILTSTONE. GREY BROWN. LAMINATED. FOSSILIFEROUS (BUCHIA)
SILTSTONE. OLIVE-GREY (5 YR 4/1). MICACEOUS
SANDSTONE. PALE OLIVE (10 YR 6/2). VERY FINE GRAINED TO SILTY. CROSSBEDDED. LAMINATED. OCCASIONAL BURROWS.
COVERED

OUTCROP 77 RF 13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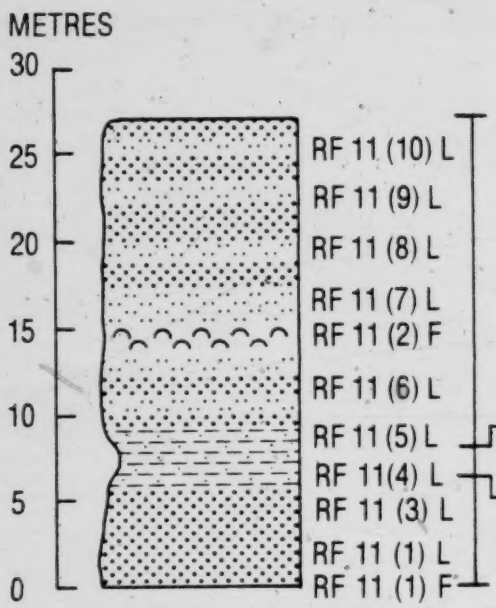
RF 13 (3) L
RF 13 (2) L
RF 13 (2) MF
RF 13 (1) L
RF 13 (1) MF
SANDSTONE. PALE YELLOW BROWN (10 YR 6/2). VERY FINE GRAINED TO SILTY. LAMINATED. CROSSBEDDED. FOSSILIFEROUS (BUCHIA)
INTERBEDDED SANDSTONE AND SILTSTONE. MINOR SHALY BEDS.
SANDSTONE. PALE YELLOW BROWN (10 YR 6/2). VERY FINE GRAINED. CROSSBEDDED. SILTSTONE LIGHT OLIVE GREY (5 YR 6/1). MICACEOUS. CARBONACEOUS.
COVERED. APPEARS TO BE INTERBEDDED SANDSTONE AND SILTSTONE. AS ABOVE.

OUTCROP 77 RF 11

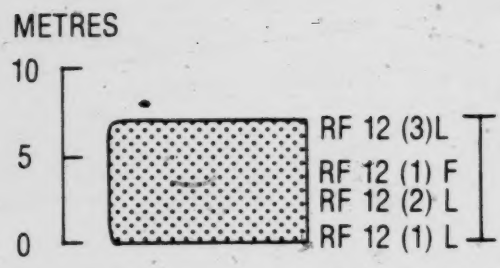


SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/2), VERY FINE GRAINED, FLAGGY TO CROSSBEDDED NUMEROUS SILTY BANDS. BUCHIA COQUINA AT 15m. SEVERAL COAL PODS AT 17m.

INTERBEDDED SHALE AND SANDSTONE WITH OCCASIONAL SILTY BANDS

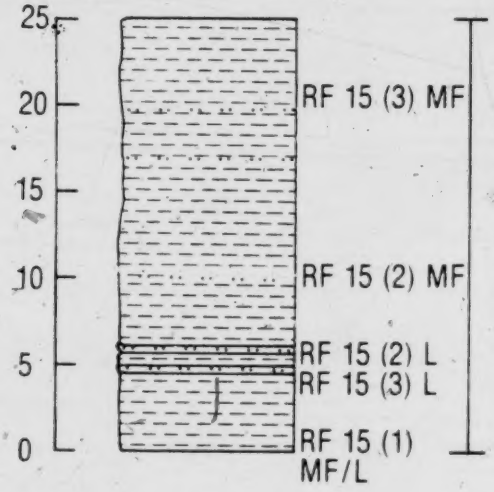
SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/1), VERY FINE GRAINED.

OUTCROP 77 RF 12



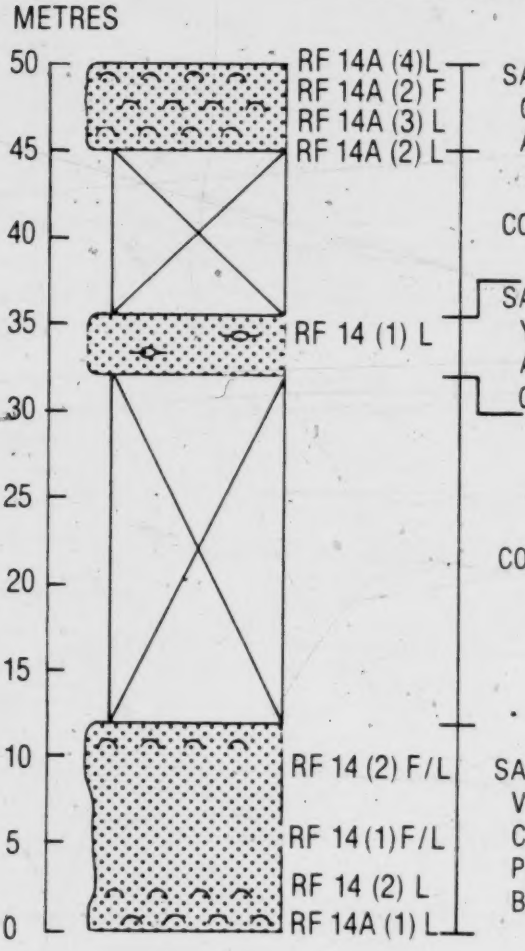
SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/2) VERY FINE GRAINED, FINE LAMINATED, CARBONACEOUS, MICACEOUS, WITH EXTENSIVE PELECYPOD BURROWS.

OUTCROP 77 RF 15



SHALE, OLIVE GREY (5 YR 4/1), SILTY, MICACEOUS, CARBONACEOUS, FISSILE
OCCASIONAL MINOR SILTSTONE LENSES THROUGHOUT.
SEVERAL THIN SILTSTONE BEDS IN LOWER PORTION OF SECTION.

OUTCROP 77 RF 14-14A



SANDSTONE, GREENISH GREY-YELLOWISH GREY, VERY FINE GRAINED, LAMINATED.
ABUNDANT PELECYPODS (COQUINA BEDS)

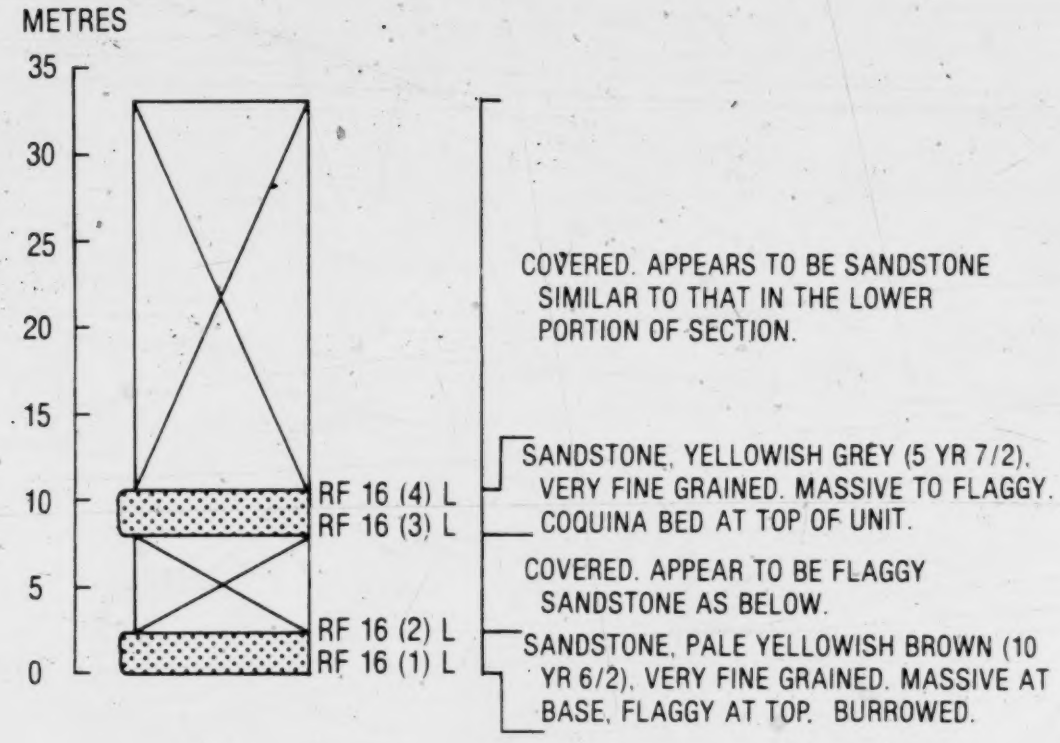
COVERED

SANDSTONE PALE YELLOWISH BROWN (10 YR 6/2), VERY FINE GRAINED. TURBATED.
ABUNDANT BURROWS. OCCASIONAL CONCRETIONS.

COVERED

SANDSTONE, VERY PALE ORANGE (10 YR 8/2), VERY FINE GRAINED. MASSIVE BECOMING CROSSBEDDED AT TOP. SEVERAL DISTINCT PELECYPOD-RICH (COQUINA BEDS).
BURROWED, TURBATED

OUTCROP 77 RF 16


METRES
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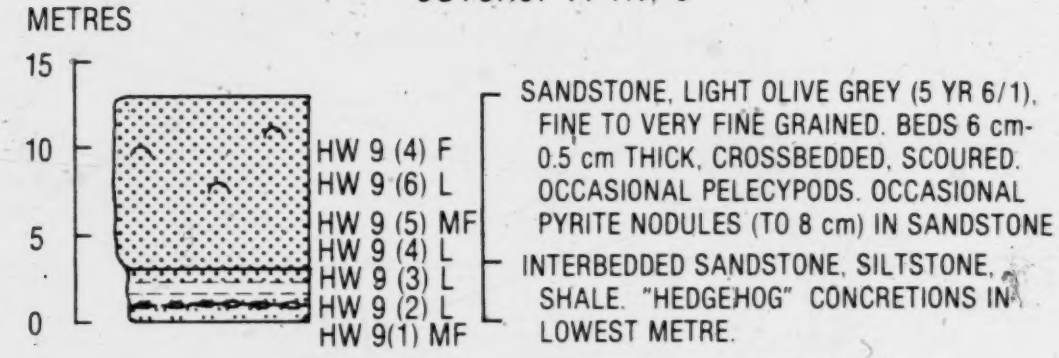
15
10
5
0
RF 16 (4) L
RF 16 (3) L
RF 16 (2) L
RF 16 (1) L
COVERED. APPEARS TO BE SANDSTONE SIMILAR TO THAT IN THE LOWER PORTION OF SECTION.
SANDSTONE, YELLOWISH GREY (5 YR 7/2), VERY FINE GRAINED. MASSIVE TO FLAGGY. COQUINA BED AT TOP OF UNIT.
COVERED. APPEAR TO BE FLAGGY SANDSTONE AS BELOW.
SANDSTONE, PALE YELLOWISH BROWN (10 YR 6/2), VERY FINE GRAINED. MASSIVE AT BASE, FLAGGY AT TOP. BURROWED.

OUTCROP 77 HW 9


METRES
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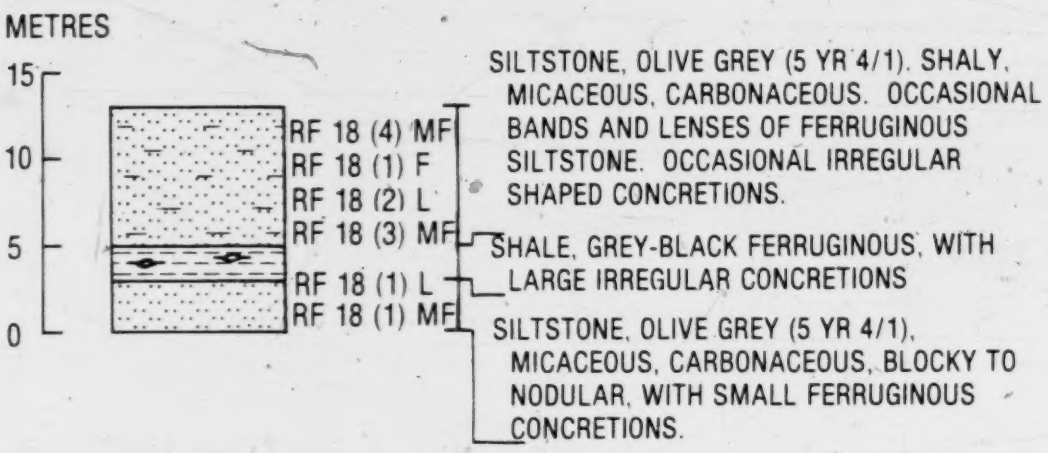
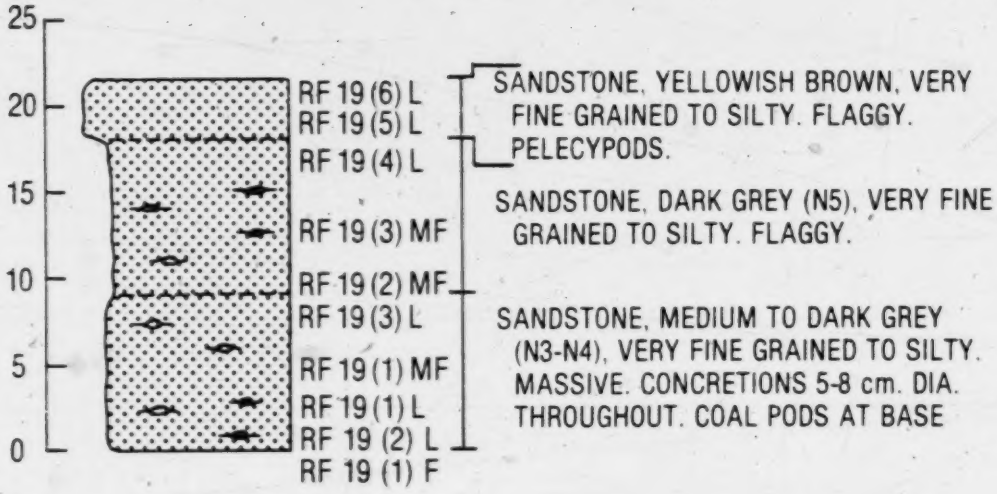
HW 9 (4) F
HW 9 (6) L
HW 9 (5) MF
HW 9 (4) L
HW 9 (3) L
HW 9 (2) L
HW 9(1) MF
SANDSTONE, LIGHT OLIVE GREY (5 YR 6/1), FINE TO VERY FINE GRAINED. BEDS 6 cm-0.5 cm THICK, CROSSBEDDED, SCOURED. OCCASIONAL PELECYPODS. OCCASIONAL PYRITE NODULES (TO 8 cm) IN SANDSTONE
INTERBEDDED SANDSTONE, SILTSTONE, SHALE. "HEDGEHOG" CONCRETIONS IN LOWEST METRE.

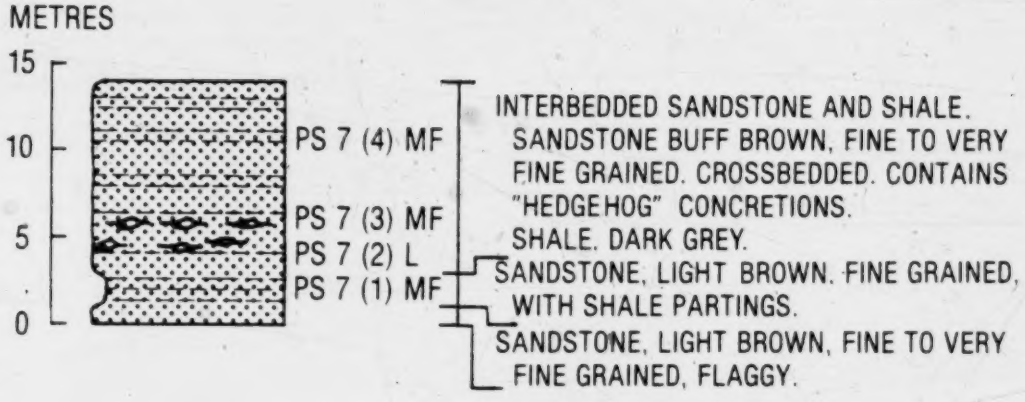
OUTCROP 77 RF 18


METRES
15
10
5
0
RF 18 (4) MF
RF 18 (1) F
RF 18 (2) L
RF 18 (3) MF
RF 18 (1) L
RF 18 (1) MF
SILTSTONE, OLIVE GREY (5 YR 4/1). SHALY, MICACEOUS, CARBONACEOUS. OCCASIONAL BANDS AND LENSES OF FERRUGINOUS SILTSTONE. OCCASIONAL IRREGULAR SHAPED CONCRETIONS.
SHALE, GREY-BLACK FERRUGINOUS, WITH LARGE IRREGULAR CONCRETIONS
SILTSTONE, OLIVE GREY (5 YR 4/1), MICACEOUS, CARBONACEOUS, BLOCKY TO NODULAR, WITH SMALL FERRUGINOUS CONCRETIONS.

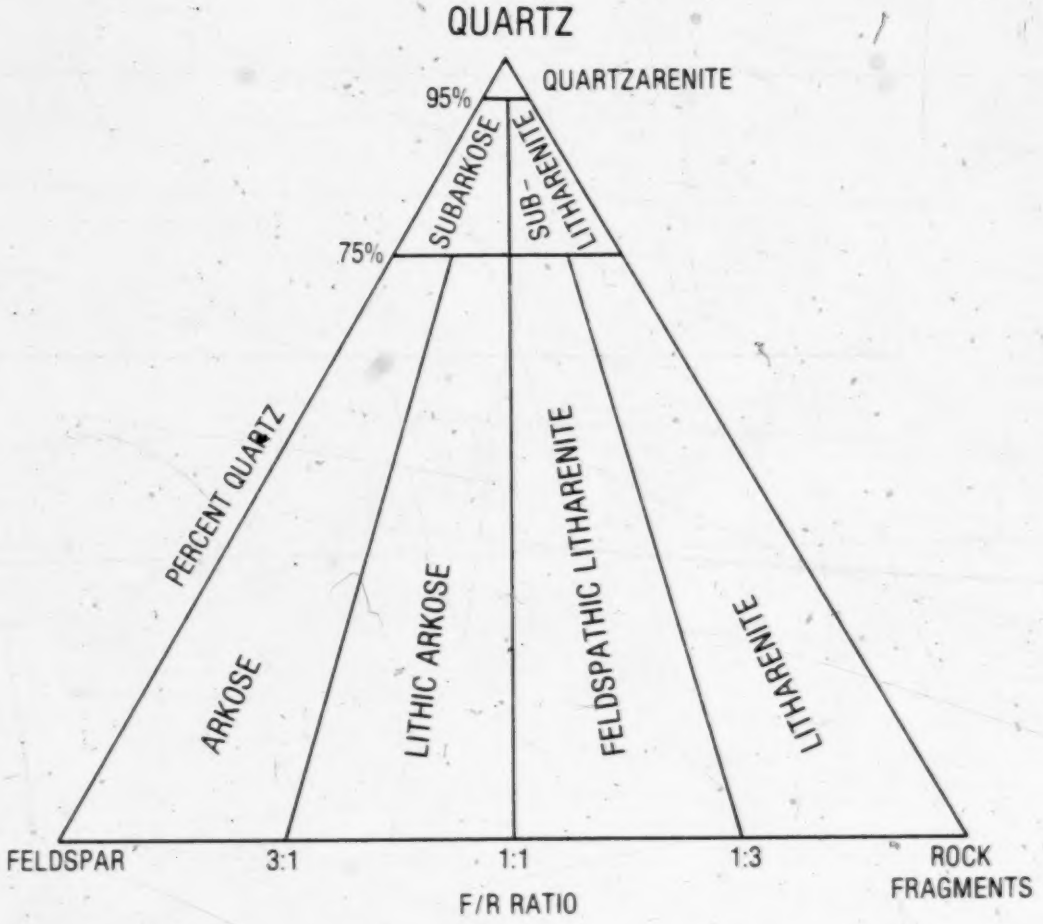
OUTCROP RF 19


METRES
25
20
15
10
5
0
RF 19 (6) L
RF 19 (5) L
RF 19 (4) L
RF 19 (3) MF
RF 19 (2) MF
RF 19 (3) L
RF 19 (1) MF
RF 19 (1) L
RF 19 (2) L
RF 19 (1) F
SANDSTONE, YELLOWISH BROWN, VERY FINE GRAINED TO SILTY. FLAGGY. PELECYPODS.
SANDSTONE, DARK GREY (N5), VERY FINE GRAINED TO SILTY. FLAGGY.
SANDSTONE, MEDIUM TO DARK GREY (N3-N4), VERY FINE GRAINED TO SILTY. MASSIVE. CONCRETIONS 5-8 cm. DIA. THROUGHOUT. COAL PODS AT BASE

OUTCROP 77 PS 7


METRES
15
10
5
0
PS 7 (4) MF
PS 7 (3) MF
PS 7 (2) L
PS 7 (1) MF
INTERBEDDED SANDSTONE AND SHALE.
SANDSTONE BUFF BROWN, FINE TO VERY FINE GRAINED. CROSSBEDDED. CONTAINS "HEDGEHOG" CONCRETIONS.
SHALE. DARK GREY.
SANDSTONE, LIGHT BROWN. FINE GRAINED, WITH SHALE PARTINGS.
SANDSTONE, LIGHT BROWN, FINE TO VERY FINE GRAINED, FLAGGY.

APPENDIX 2. Quantitative Composition



COMPOSITIONAL CLASSIFICATION OF SANDSTONE

(after Folk, 1974)

QUANTITATIVE COMPOSITION

Q = QUARTZ R = ROCK FRAGMENTS F = FELDSPAR
C = CEMENT, MATRIX A = ACCESSORIES P = POROSITY

SAMPLE NUMBER	PERCENT OF ESSENTIALS			PERCENT OF TOTAL			ROCK CLASSIFICATION (AFTER FOLK, 1974)
	Q	R	F	C	A	P	
77 RF 4 (1)	87.9	8.3	3.8	13.3	4.3	2.3	sublitharenite
77 RF 4 (2)	90.8	6.6	4.4	13.0	5.3	4.7	sublitharenite
77 RF 4 (3)	94.8	1.7	3.5	13.7	3.7	6.3	subarkose
77 RF 4 (4)	91.5	4.5	4.0	22.0	3.0	0.0	sublitharenite
77 RF 4 (5)	96.0	1.5	2.5	24.0	1.7	6.7	quartzarenite
77 RF 5 (1)	89.7	5.4	4.9	20.7	0.7	8.7	sublitharenite
77 RF 5 (2)	92.6	3.2	4.2	10.3	1.7	16.3	subarkose
77 RF 5 (3)	90.7	4.4	4.9	16.3	1.3	7.3	subarkose
77 RF 5 (4)	96.5	0.0	3.5	30.7	0.7	0.0	quartzarenite
77 RF 5 (5)	91.4	2.7	5.9	20.7	1.7	3.3	subarkose
77 RF 5A (1)	98.1	1.9	0.0	11.0	5.7	12.7	quartzarenite
77 RF 5A (2)	87.7	2.7	9.5	19.7	2.7	4.7	subarkose
77 RF 7 (1)	84.5	5.3	10.2	26.0	3.0	1.0	subarkose
77 RF 8 (1)	83.9	3.4	12.7	23.3	5.7	0.0	subarkose
77 RF 8 (2)	82.1	7.6	10.3	19.0	6.0	0.0	subarkose

SAMPLE NUMBER	PERCENT OF ESSENTIALS			PERCENT OF TOTAL			ROCK CLASSIFICATION (AFTER FOLK, 1974)
	Q	R	F	C	A	P	
77 RF 10 (1)	67.5	7.2	25.3	33.0	2.3	0.0	arkose
77 RF 10 (2)	79.2	3.6	17.2	23.3	4.7	0.0	subarkose
77 RF 10 (3)	76.1	3.2	20.7	22.0	5.7	9.7	subarkose
77 RF 10 (4)	79.8	6.1	14.1	32.0	2.0	0.0	subarkose
77 RF 13 (1)	92.7	6.5	0.8	14.0	2.0	2.0	sublitharenite
77 RF 13 (2)	88.4	3.6	8.0	12.7	3.3	0.7	subarkose
77 RF 13 (3)	94.7	2.9	2.4	30.0	0.7	0.0	sublitharenite
77 RF 13 (4)	94.0	5.1	0.9	7.0	1.3	14.0	sublitharenite
77 RF 11 (1)	90.4	6.8	2.8	15.0	2.7	8.3	sublitharenite
77 RF 11 (3)	90.4	5.7	3.9	12.0	2.7	9.0	sublitharenite
77 RF 11 (5)	93.1	4.4	2.5	12.0	2.3	18.0	sublitharenite
77 RF 11 (6)	94.8	4.3	0.9	13.0	1.0	9.3	sublitharenite
77 RF 11 (7)	89.8	6.3	3.9	21.7	1.0	8.7	sublitharenite
77 RF 11 (8)	88.9	6.2	4.9	13.0	1.0	5.0	sublitharenite
77 RF 11 (9)	90.4	3.8	5.8	18.7	2.0	3.0	subarkose
77 RF 11 (10)	91.9	3.8	4.3	14.3	3.0	4.3	subarkose
77 RF 12 (1)	90.2	4.0	5.8	11.0	8.7	3.7	subarkose
77 RF 12 (2)	87.8	3.6	8.6	16.3	2.0	7.7	subarkose
77 RF 12 (3)	89.8	3.4	6.8	30.3	0.7	0.0	subarkose

SAMPLE NUMBER	PERCENT OF ESSENTIALS			PERCENT OF TOTAL			ROCK CLASSIFICATION (AFTER FOLK, 1974)
	Q	R	F	C	A	P	
77 RF 14 (1)	93.2	5.4	1.4	10.7	1.0	15.0	sublitharenite
77 RF 14 (2)	96.8	1.6	1.6	35.7	1.3	0.0	quartzarenite
77 RF 14A (1)	98.1	1.4	0.5	8.0	3.0	17.7	quartzarenite
77 RF 14A (2)	95.0	3.6	1.4	32.3	2.7	0.0	quartzarenite
77 RF 14A (3)	95.1	3.3	1.6	37.3	1.3	0.0	quartzarenite
77 RF 14A (4)	94.0	5.1	0.9	11.0	0.3	16.3	sublitharenite
77 RF 16 (2)	97.8	1.1	1.1	34.3	4.7	0.0	quartzarenite
77 RF 16 (3)	95.7	2.9	1.4	13.3	1.0	15.0	quartzarenite
77 RF 16 (4)	97.2	1.7	1.1	39.3	1.7	0.0	quartzarenite
77 HW 9 (3)	78.5	5.1	16.4	9.7	9.7	8.7	subarkose
77 HW 9 (4)	88.6	2.5	8.9	12.3	11.1	10.0	subarkose
77 HW 9 (6)	75.7	4.1	20.2	39.7	2.7	0.0	subarkose
77 RF 19 (1)	77.5	16.6	5.9	28.3	9.3	0.0	sublitharenite
77 RF 19 (3)	70.9	18.5	10.6	17.7	6.7	0.0	litharenite
77 RF 19 (4)	77.3	17.4	5.3	18.3	12.7	0.0	sublitharenite
77 RF 19 (5)	83.1	11.0	5.9	11.0	2.7	1.3	sublitharenite
77 RF 19 (6)	82.3	12.1	5.6	17.7	5.0	0.0	sublitharenite
77 PS 7 (1)	89.7	7.4	2.9	17.3	1.7	0.0	sublitharenite

CEMENTS, MATRIX AND ACCESSORY MINERALS

(NUMBER OUT OF 300 POINTS COUNTED)

CEMENTS AND MATRIX: Q = QUARTZ, Ct = CHERT, K = KAOLINITE, Cy = OTHER CLAYS, C = CALCITE, Ch = CHLORITE

ACCESSORY MINERALS: M = MUSCOVITE, Ch = CHLORITE, G = GLAUCONITE, F = IRON OXIDE, P = PYRITE, Z = ZIRCON, E = EPIDOTE, O = ORGANIC, U = UNKNOWN

SAMPLE NUMBER	CEMENTS AND MATRIX						ACCESSORY MINERALS								
	Q	Ct	K	Cy	C	Ch	M	Ch	G	F	P	Z	E	O	U
77 RF 4 (1)	26	5	4	5				2		10					1
77 RF 4 (2)	19	1	8	8		3				14		1		1	
77 RF 4 (3)	33	1	3	4						10					1
77 RF 4 (4)	53	6	3	4						5		2		1	1
77 RF 4 (5)	49	4	4	13		2	1			2				1	1
77 RF 5 (1)	30	4		19		9				2					
77 RF 5 (2)	14		1	14		2			1	1		2			1
77 RF 5 (3)	36	2	1	10				2		1					1
77 RF 5 (4)					92							2			
77 RF 5 (5)	45	4	3	10			1			4		1		1	
77 RF 5A (1)	23		2	7		1	1		13						3
77 RF 5A (2)	31	11	5	10		1	2		4				2		

SAMPLE NUMBER	CEMENTS AND MATRIX						ACCESSORY MINERALS								
	Q	Ct	K	Cy	C	Ch	M	Ch	G	F	P	Z	E	O	U
77 RF 7 (1)	40	9	3	24		2	3			3	1	1		1	
77 RF 8 (1)	36	3	3	23	4	1	1			16					
77 RF 8 (2)	38	7	1	11			4			11		3			
77 RF 10 (1)	8			3	88		1			5	1				
77 RF 10 (2)	20	5	5	23		17				14					
77 RF 10 (3)	11	7		25		21				15				1	1
77 RF 10 (4)	3	1		10	78	4			1	3			1	1	
77 RF 13 (1)	25	3	1	11		2				5					1
77 RF 13 (2)	14	1	5	5	12	1	3			4	3				
77 RF 13 (3)	5			2	83				2						
77 RF 13 (4)	14	2	1	4					2				1		1
77 RF 11 (1)	42	2		4				1		6					1
77 RF 11 (3)	25	1	4	5		1				6					2
77 RF 11 (5)	30			6			1	1							5
77 RF 11 (6)	27	3	4	5					1	2					
77 RF 11 (7)	54	3	1	3		2								2	1
77 RF 11 (8)	26	7		4		2				1		1			1

SAMPLE NUMBER	CEMENTS AND MATRIX						ACCESSORY MINERALS								
	Q	Ct	K	Cy	C	Ch	M	Ch	G	F	P	Z	E	O	U
77 RF 11 (9)	32	6	1	9		2	3		1	1			1		
77 RF 11 (10)	12	7	3	18		3			1	7					1
77 RF 12 (1)	16			13		4				23				3	
77 RF 12 (2)	25	10	5	4		1				4				1	1
77 RF 12 (3)	3				88		1							1	
77 RF 14 (1)	25	2	1	2		2			3						
77 RF 14 (2)	35				72				4						
77 RF 14A (1)	22			1		1			6	3					
77 RF 14A (2)					96				5	3					
77 RF 14A (3)					112				2					2	
77 RF 14A (4)	28			5					1						
77 RF 16 (2)					103				6	2				4	2
77 RF 16 (3)	34	3	2	1					2					1	
77 RF 16 (4)					118				3			1		1	
77 HW 9 (3)	19	1		9			4	8	2	11					4
77 HW 9 (4)	20			17			3	15		10	1			2	2
77 HW 9 (6)				2	117		1			6		1			
77 RF 19 (1)	25	3		50	7		5		4	7	5			1	6
77 RF 19 (3)	19	4	1	18	11		2	1		8	1			5	3
77 RF 19 (4)	15	12		27	1		3		4	5	4	1		20	1
77 RF 19 (5)	21	1		10		1	1			4					3
77 RF 19 (6)	30	3		18	2		2		1	4	1	1			6
77 PS 7 (1)	37	2		4	9		2			2					1

APPENDIX 3. Macropaleontology

The following is an exerpt from a report by Dr. J.A.Jeletzky of the Geological Survey of Canada, entitled "Report on Cretaceous and Jurassic fossils collected in northeastern Richardson Mountains by geologists of Petro-Canada Exploration Inc. in 1977 and submitted by Dr. P.F. Sherrington (Micropaleontologist) on Aug. 15, 1977. (NTS-107, B3; 117, A1, A8) Report No. Km-6-1977-JAJ"

77RF 1(1) GSC. loc. 95053

cf. Acroteuthis pseudopanderi (Sintsov)

Age and correlation: Possibly the same as for lot 93052. However, lot 95053 cannot be dated definitively as of that age because of a very poor preservation of the only fragment available. Lot 95053 is at any rate of the Early to Mid-Cretaceous (ie. Berriasian to early Aptian) age.

77RF 4(1) GSC. loc. 95043

Buchia n. sp. aff. volgensis (Lahusen, 1888) (numerous and well preserved, advanced forms)

Age and correlation: Late Berriasian to ?earliest Valanginian age in terms of the international standard stages, and either from the uppermost part of Husky Formation or from the lower part (i.e. Buff sandstone member or its argillaceous equivalents) of the Lower sandstone division of Jeletzky (see GSC Paper 58-2, pp. 6-7; GSC Paper 61-9, pp. 9-12, and GSC Paper 66-50, p. 33 for further details). Judging by the matrix and the advanced morphology of all specimens available, lot 95043 was collected from some part of the Buff sandstone member.

Buchia n. sp. aff. volgensis was listed as Buchia volgensis (Lahusen) in the above cited publications. However, it was concluded subsequently that it is not conspecific with the European and Siberian form concerned. Hence the change of the name.

77RF 8(1) GSC loc. 95047.

Buchia n. sp. aff. volgensis (Lahusen, 1888) (well preserved, advanced forms; prevalent)
Buchia aff. B. okensis (Pavlow) f. typ. (a single left valve)

Age and correlation: The same as for lots 95043 and 95044. Like these two lots, lot 95047 presumably was derived from the Buff sandstone member of Lower sandstone division.

77RF 8(T) GSC loc. 95087

No identifiable fossils seen (only trail markings)

Age and correlation: Cannot be dated

77 RF 10(1) GSC loc. 95046

Indeterminate fragments of pelecypods

Age and correlation: Cannot be dated.

77RF 10(4A) GSC loc. 95042

cf. Buchia (Anaucella) concentrica (Sowerby) s. lato (a single fragmentary left valve)
Indeterminate marine pelecypods

Age and correlation: Possibly the same as for lots 95029, 95030 and other lots of that group. However, the only specimen of pelecypod compared with Buchia (Anaucella) concentrica s. lato is too poorly preserved to be identified positively even to the subgenus Anaucella. Lot 95042 can only be identified definitively as of a general Late Jurassic (i.e. late Oxfordian to late late Tithonian) age.

77RF 13(1) GSC loc. 95045

Buchia n. sp. aff. volgensis (Lahusen, 1888) (mostly poorly to very poorly preserved)

Age and correlation: The same as for lots 95043 and 95044. However, the poor preservation of most shells and the indifferent character of the matrix do not permit any decision as to whether lot 95045 is derived from the uppermost Husky Fromation or from the Buff sandstone member of the Lower sandstone division.

77RF 11(2) GSC loc. 95051

Fragments of indeterminate pelecypods

Age and correlation: Cannot be dated.

77RF 11(2) GSC loc. 95044

Buchia n. sp. aff. volgensis (Lahusen, 1888) (numerous and well preserved, advanced forms)

Age and correlation: The same as for lot 95043. Like this lot, lot 95044 presumably is derived from the Buff sandstone member of the Lower sandstone division.

77RF 14(1) GSC loc. 95048

Panope? elongatissima McLearn
Arctica? (s. lato) sp. indet.
(presumably the same form as in Imlay, 1961, pl. 6, figs. 11-14, 6)

Age and correlation: The same as for lot 95028. Because of the general appearance of the arenaceous matrix, the writer is inclined to think that lot 95048 is derived from the Upper sandstone division. However, this is an educated guess only.

77RF 14(2) GSC loc. 95049

Panope? elongatissima McLearn
Arctica? (s. lato) indet.
(the same as in lot 95048)

Age and correlation: The same as for lot 95048.

77RF 14(3) GSC loc. 95050

Arctica? (s. lato) sp. indet.
(the same form as reproduced in Imlay, 1961, Pl. 6, fig. 11-14, 16)
cf. Flaventia Kukpowrukensis Imlay
Indeterminate pelecypods

Age and correlation: The same as for lots 95028, 95048 and other lots of that group. Like lot 95048, lot 95050 may have been derived from the Upper sandstone division.

77RF 14A(49 m.) GSC loc. 95954

cf. Acroteuthis pseudopanderi (Sintsov)
cf. Panope sp. indet.

Age and correlation: The same as for lot 95053, except that the sandstone matrix of the specimen and the presence of a Panope-like pelecypod suggest (but do not prove) the derivation of lot 95054 from the Upper sandstone division.

77HW 9(4) GSC loc. 95078

Indeterminate fragments of pelecypods.

Age and correlation: Cannot be dated.

77RF 18(1) GSC loc. 95052

Acroteuthis n. sp. aff. conoides Swinnerton 1937
(the form figured in Jeletzky, GSC Paper 64-11, pl. XIX, fig. 1)(the only specimen to Index Collection)

Age and correlation: So far as known, Acroteuthis n. sp. aff. conoides Swinnerton 1937 and allied forms (e.g. Acroteuthis pseudopanderi Sintsov) are restricted to the Upper member of the Upper shale-siltstone division and the basal 120 feet of the Upper sandstone division (see Jeletzky, GSC Paper 58-2, pp. 12-13; GSC Paper 59-14, pp. 16, 17). They are, therefore, of the late Barremian to early Aptian age in terms of the international standard stages (see Jeletzky, GSC Paper 64-11, Table 1). Lot 95052 could have been derived from either of the two above mentioned mid-Lower Cretaceous units.

77RF 19(1) GSC loc. 95541

Aucellina ex gr. aptiensis Popeckj-caucasica Abich

Age and correlation: Late Barremian to Aptian in terms of the international standard stages and from some part of Aucellina aptiensis-Aucellina caucasica Zone (see Jeletzky, GSC Paper 59-14, pp. 16, 17; GSC Paper 64-11, Table 1). Generally speaking, this fauna could have been collected either from the upper part of the Upper member of the Upper shale-siltstone division or from the Upper sandstone division (see Jeletzky, GSC Paper 58-2, pp. 13-14). However, judging by the brownish grey sandy siltstone matrix, lot 95541 was collected from the uppermost 200 feet of the Upper shale-siltstone divison.

77RF 19(2) GSC loc. 95059

Indeterminate pelecypods

Age and correlation: Cannot be dated.

77FC 23 GSC loc. 95028

Ihracia stelcki McLearn
Modiolus sp. indet.
?Yoldia sp. indet.
Indeterminate pelecypods

Age and correlation: The long-ranging plecypod fauna of lot 95028 had been for a long time considered to be diagnostic of the Albian stage in terms of the international standard (e.g. Jeletzky, GSC Paper 59-14, pp. 18-19; Imlay 1961, USGS Prof. Paper 335, 1960). However, it is now known to be long-ranging. The oldest examples of this fauna are known to occur in the late Hauterivian Lower member of the Upper shale-siltstone division (especially in its so called Arenaceous facies; e.g. Jeletzky, GSC Paper 74-10, p. 18). Lot 95028 can accordingly only be dated as of mid-to-late Early Cretaceous (i.e. late Hauterivian to Albian) age. In northern Richardson Mountains it could be derived from the Upper shale-siltstone division and its equivalents, from the argillaceous equivalents of the Upper sandstone division, or from the overlying argillaceous Albian rocks.

77FC 11(6) GSC loc. 95029

Buchia (Anaucella) concentrica (Sowerby) s.

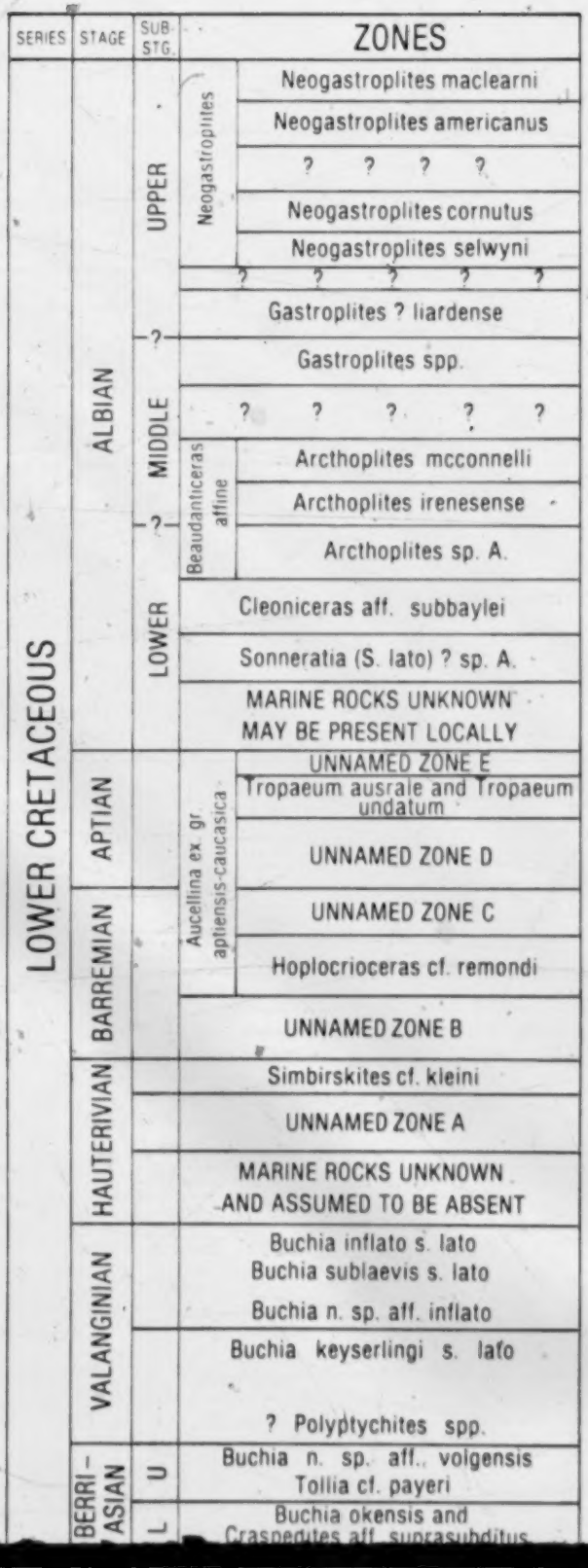
lato
(?early forms)

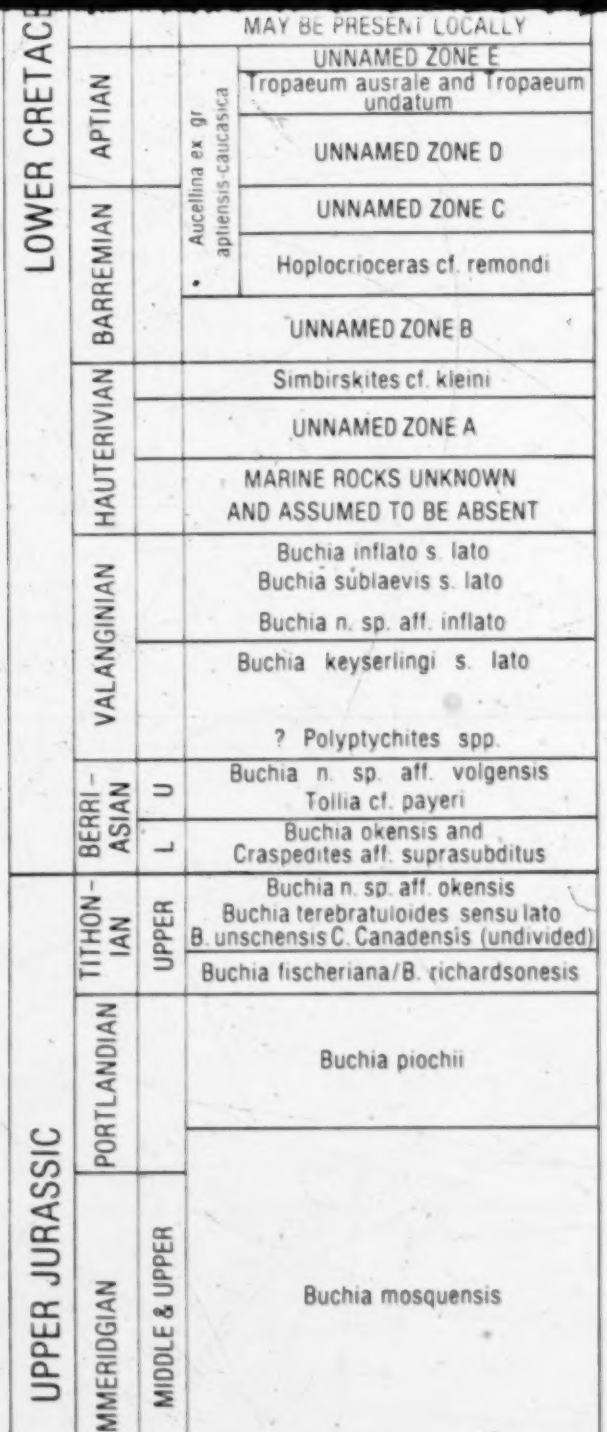
Age and correlation: Some part (probably early) of the Buchia (Anaucella) concentrica Zone and of the late Oxfordian or early Kimmeridgian age in terms of the international standard (see Jeletzky, GSC Paper 66-50, p. 36 for further details). In northern Richardson Mountains and on the Arctic Coastal Plain the Buchia (Anaucella) concentrica s. lato fauna occurs either in the lowermost part of the Husky Formation and high in the Kingak Formation or in the eastward pinching out tongues of the Porcupine River Formation (see Jeletzky, GSC Paper 76-27, p. 19-20).

77FC 11(14A) GSC loc. 95030

Buchia (Anaucella) concentrica (Sowerby) s. lato

Age and correlation: The same as for lot 95029. The fossils are too poorly preserved to suggest from which part of Buchia (Anaucella) concentrica s. lato Zone they are derived.


SERIES
STAGE
SUB STG.
ZONES
LOWER CRETACEOUS
ALBIAN
UPPER
MIDDLE
LOWER
Neogastroplites
Neogastroplites maclearni
Neogastroplites americanus
? ? ? ?
Neogastroplites cornutus
Neogastroplites selwyni
? ? ? ? ?
Gastroplites ? liardense
Gastroplites spp.
? ? ? ? ?
Beaudanticeras affine
Arcthoplites mcconnelli
Arcthoplites irenesense
Arcthoplites sp. A.
Cleoniceras aff. subbaylei
Sonneratia (S. lato) ? sp. A.
MARINE ROCKS UNKNOWN
MAY BE PRESENT LOCALLY
APTIAN
Aucellina ex. gr. aptiensis-caucasica
UNNAMED ZONE E
Tropaeum ausrale and Tropaeum undatum
UNNAMED ZONE D
BARREMIAN
UNNAMED ZONE C
Hoplocrioceras cf. remondi
UNNAMED ZONE B
HAUTERIVIAN
Simbirskites cf. kleini
UNNAMED ZONE A
MARINE ROCKS UNKNOWN
AND ASSUMED TO BE ABSENT
VALANGINIAN
Buchia inflato s. lato
Buchia sublaevis s. lato
Buchia n. sp. aff. inflato
Buchia keyserlingi s. lato
? Polyptychites spp.
BERRI-ASIAN
U
Buchia n. sp. aff.. volgensis
Tollia cf. payeri
L
Buchia okensis and
Craspedites aff. suprasubditus



GENERAL MACROFOSSIL ZONATION CHART

(after Jeletzky, 1964, 1966, 1967, 1971, 1973)

2 of 2

APPENDIX 4. Micropaleontology

Preliminary Micropalaeontological Zonation of the Upper Jurassic and Lower Cretaceous Succession of the Northern Richardson Mountains with Special Reference to the Cache Creek Study Area
Project No. B/S-1 - Interim Report

P. Sherrington

Introduction

Over 250 samples were collected for micropalaeontological analysis by the members of the Petro-Canada/Chevron 1977 field party in the northern Richardson Mountains, Yukon and N.W.T. Formations sampled ranged from Husky Formation (Late Jurassic, Oxfordian) to the Boundary Creek Formation (Late Cretaceous, Campanian/Maastrichtian). The preliminary zonation was based on these samples, supplemented by data from wells adjacent to the area.
Thirty-seven samples from sixteen sections in the Cache Creek study area were available for analysis and the results are summarized in the table provided.

OUTLINE OF THE ZONAL SCHEME (OXFORDIAN - EARLY APTIAN)

Zone Ju (undifferentiated) (Oxfordian to Berriasian, Husky Formation)

The samples collected during the 1977 field season did not permit a fine subdivision of the Upper Jurassic and lowest Cretaceous strata and an undifferentiated Ju zone was used. Extensive and close-spaced sampling of the Husky Formation in the northern Richardson Mountains was undertaken during the summer of 1978. Very rich microfaunas were recovered, and a finer zonation than that based on the 1977 samples will be achieved.

In the 1977 samples, the Ju zone is characterized by fairly abundant microfaunas dominated by agglutinating species. The following species may be considerd characteristic of the zone:

- *Haplophragmoides barrowensis* (usually common to abundant)
- *Ammobaculites alaskensis*
- *Recurvoides* aff. *sublustris*
- *Haplophragmoides* cf. *tryssa*
- *Arenoturrispirillina* aff. *waltoni*
- *Trochammina sablei*

Calcareous foraminifera are generally rare and poorly preserved, the most commonly encountered species being *Globulina topagorukensis*.

Samples RF 10(1 and 2) yielded poorly preserved, but fairly common foraminifera including:

Cribrostomoides canui
Haplophragmoides barrowensis
Recurvoides aff. sublustris

Samples from HW 8 yielded rich agglutinating foraminiferal assemblages of fairly low specific diversity typical of the upper part of the Husky Formation, and probably of (Upper Kimmeridgian)-Berriasian age. (Provisionally, Zone Ju II). Species include:

C. Canui (rare)
Ammobaculites alaskensis (abundant)
H. barrowensis (abundant)
distinctive species of Recurvoides and Glomospirella

Zone KL1 1a, Late Berriasian - early Valanginian

This zone is poorly characterized and was only rarely encountered in the 1977 samples. The assemblage is dominated by species of Haplophragmoides of late Jurassic aspect (H. barrowensis etc.), together with common Globulina sp. (probably G. topagorukensis).
Samples RF 13 and RF 7 yielded this assemblage, and are therefore considered to come from the upper part of the buff sandstone unit of the lower sandstone division (K1).

Zone KL 1b, Valanginian

Assemblages recovered from the blue-grey shale unit of the lower sandstone division proved to be diverse and distincitve. Many of the species are of Late Jurassic aspect, e.g. cribrostomoides aff. canui, Haplophragmoides barrowensis, and Trochammina aff. gryci although species such as Saracenaria valanginiana, typical of the Early Cretaceous are also present. The most distincitve elements of the assemblage, however, are undescribed and are predominantly species of Ammobaculites, Trochammina, Spiroplectammina and Pseudobolivina.

No assemblages ascribable to this zone were encountered in the 1977 RF samples.

Zone KL2 I, early Hauterivian

A distinctive and widespread assemblage was recoverd from the lowest part of the upper shale-siltstone division (K2). Agglutinating foraminifera dominate the assemblage, with calcareous species uncommon or rare. Haplophragmoides inflatigrandis and H. duoflatis occur together with abundant, coarsely agglutinated species of Reophax and Ammobaculites. It is possible that this zone represents an ecologically controlled, shallow water microfauna developed

near the base of the upper shale-siltstone division. The assemblage is widespread, however, and is useful for defining the lowest part of the division.

No assemblages ascribable to this zone were encountered in the 1977 RF samples.

Zone KL2 II, mid Hauterivian

This zone is characterized by abundant microfaunas, typically dominated by a great diversity of calcareous forms. The zone probably represents the maximum transgressive phase of the Neocomian sea in the Richardson Mountains area. Typical calcareous species include Marginulinopsis collinsi, M. gracilissima, Dentalina strangulata, Globulina prisca, G. exserta, Lagena hauteriviana hauteriviana, Citharian cf. perstriata, Globorotalites sp., Saracenaria projectura, S. spinosa, S. gradstandensis, S. aff. valanginiana, S. dutroi, Lenticulina bayrocki, L. macroisca, L. aff. erecta, L. aff. saxonica, Praebulimina sp. 1, Patellina sp. 1, Gavelinella cf. barremiana, together with a considerable number of undescribed species. Agglutinating species are also common and include Haplophragmoides inflatigrandis, H. duoflatis, Glomospirella arctica, Glomospira subarctica saturna, Reophax tundraensis and Gaudryina tappanae.

No assemblages ascribable to this zone were encountered in the 1977 RF samples.

Zone KL2 III, late Hauterivian - ?early Barremian

This zone is similar to KL2 II, although somewhat less diverse. It is mainly differentiated by the presence of Gravellina sp. 1, a seemingly short-ranging species that was widespread and is an excellent index species for the Hauterivian - Barremian boundary. Both Praebulimina sp. 1, and Gaudryina tappanae are usually common to abundant in this zone.

Samples RF 2(3) and RF 15(3) yielded a mainly agglutinating microfauna and are placed in this zone based on the presence of Gravellina sp. 1, and common Gaudryina tappanae.

Sample RF 3 yielded very common Gravellina sp. 1, and Gaudryina tappanae, as conspicuous elements in a rich, mainly agglutinating microfauna.

Zone KL2 IV, Barremian

Foraminifera are generally less abundant and diverse in this zone compared to those in the Hauterivian, probably reflecting a prolonged period of regression in the upper part of the K2 shale. Agglutinating species are dominant and include Gaudryina tappanae, Verneuilinoides sp., Hippocrepina sp., Ammobaculites ex. gr. fragmentarius and, most typically, Gaudryina aff. subcretacea. Calcareous

species are generally uncommon, but a small, five-chambered species of Qudrimorphina, is sometimes present. This assemblage was encountered in RF 1(3), (4), (5), RF 2(1), RF 18(1), (3), and RF 19(1). The following are questionably assigned to the zone: RF 1(1), (2), RF 2(2), and RF 5A.

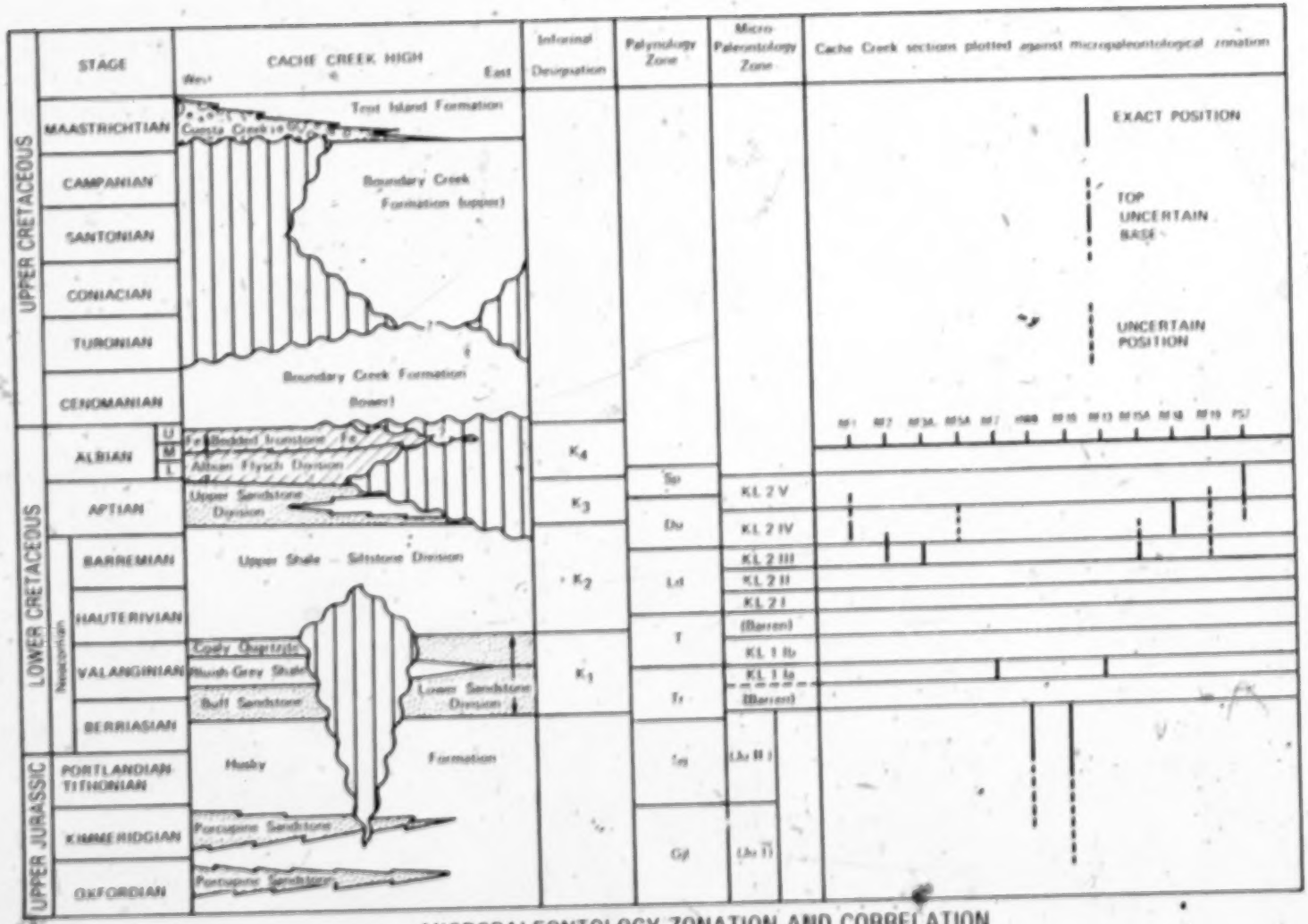
Zone KL2 V, late Barremian - early Aptian

This zone is characterized by a predominance of Haplophragmoides of the group H. topagorukensis, together with the occurrence of distinctive species of Uvigerinammina, Verneuilinoides and Textularia. Calcareous species occur only rarely. The zone is developed at the top of the K2 shale, and in argillaceous beds in the upper sandstone division (K3). This assemblage was encountered in PS 7(1, 3, and 4).

SAMPLE	AGE (based on micropaleontology)	FORMATION	ZONE
RF 1 (1)	?BARREMIAN	K2	?KL2 IV
(2)	?BARREMIAN	K2	?KL2 IV
(3)	BARREMIAN	K2	KL2 IV
(4)	BARREMIAN	K2	KL2 IV
(5)	BARREMIAN	K2	KL2 IV
RF 2 (1)	BARREMIAN	K2	KL2 IV
(2)	BARREMIAN	K2	?KL2 IV
(3)	L. HAUTERIVIAN-E. BARREMIAN	K2	KL2 III
RF 3 (1)	L. HAUTERIVIAN-E. BARREMIAN	K2	KL2 III
RF 5A (1)	?BARREMIAN	?K2	?KL2 IV
RF 7 (1)	L. BERRIASIAN - E. VALANGINIAN	K1	KL2 I
RF 8 (1)	?	?	
HW 8 (1)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(2)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(3)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(5)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(6)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
RF 10 (1)	(OXFORDIAN) KIMMERIDGIAN-BERRIASIAN	HUSKY	JU
(2)	(OXFORDIAN) KIMMERIDGIAN-BERRIASIAN	HUSKY	JU
RF 13 (1)	L. BERRIASIAN-E. VALANGINIAN	K1	KL1 I
(2)	L. BERRIASIAN-E. VALANGINIAN	K1	KL1 I
RF 11 (1)	?	?	
RF 15 (1)	?	?	
(2)	HAUTERIVIAN OR BARREMIAN	?	KL2
(3)	L. HAUTERIVIAN-E. BARREMIAN	?	KL2 III
(4)	?	?	
HW 9 (1)	?	?	
(5)	?	?	
RF 18 (1)	BARREMIAN	K2	KL2 IV
(2)	BARREMIAN	K2	KL2 IV
(4)	BARREMIAN	K2	KL2 IV
RF 19 (1)	HAUTERIVIAN OR BARREMIAN	K2	KL2
(2)	HAUTERIVIAN OR BARREMIAN	K2	KL2
(3)	BARREMIAN-APTIAN	K2/K3	
PS 7 (1)	BARREMIAN-APTIAN	K3	KL2 V
(3)	BARREMIAN-APTIAN	K3	KL2 V
(4)	BARREMIAN-APTIAN	K3	KL2 V

(5)	BARREMIAN	K2	KL2 IV
RF 2 (1)	BARREMIAN	K2	KL2 IV
(2)	BARREMIAN	K2	?KL2 IV
(3)	L. HAUTERIVIAN-E. BARREMIAN	K2	KL2 III
RF 3 (1)	L. HAUTERIVIAN-E. BARREMIAN	K2	KL2 III
RF 5A (1)	?BARREMIAN	?K2	?KL2 IV
RF 7 (1)	L. BERRIASIAN - E. VALANGINIAN	K1	KL2 I
RF 8 (1)	?	?	
HW 8 (1)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(2)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(3)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(5)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
(6)	(L. KIMMERIDGIAN) - BERRIASIAN	HUSKY	JU (= JU II)
RF 10 (1)	(OXFORDIAN) KIMMERIDGIAN-BERRIASIAN	HUSKY	JU
(2)	(OXFORDIAN) KIMMERIDGIAN-BERRIASIAN	HUSKY	JU
RF 13 (1)	L. BERRIASIAN-E. VALANGINIAN	K1	KL1 I
(2)	L. BERRIASIAN-E. VALANGINIAN	K1	KL1 I
RF 11 (1)	?	?	
RF 15 (1)	?	?	
(2)	HAUTERIVIAN OR BARREMIAN	?	KL2
(3)	L. HAUTERIVIAN-E. BARREMIAN	?	KL2 III
(4)	?	?	
HW 9 (1)	?	?	
(5)	?	?	
RF 18 (1)	BARREMIAN	K2	KL2 IV
(2)	BARREMIAN	K2	KL2 IV
(4)	BARREMIAN	K2	KL2 IV
RF 19 (1)	HAUTERIVIAN OR BARREMIAN	K2	KL2
(2)	HAUTERIVIAN OR BARREMIAN	K2	KL2
(3)	BARREMIAN-APTIAN	K2/K3	
PS 7 (1)	BARREMIAN-APTIAN	K3	KL2 V
(3)	BARREMIAN-APTIAN	K3	KL2 V
(4)	BARREMIAN-APTIAN	K3	KL2 V

SUMMARY OF MICROPALEONTOLOGY ANALYSES



MICROPALEONTOLOGY ZONATION AND CORRELATION

APPENDIX 5. Palynology

The following palynological data were compiled from samples collected along Cache Creek, N.W.T. The results presented below also appear graphically in the accompanying chart following the sample descriptions.

77RF 1

The samples contained moderately rich microplankton flora. The occurrence of Subtilisphaera perlucida, S. pirnaensis, Muderongia mchwaei, M. tetracantha, Pseudoceratium nudum, etc., is indicative for the "Subtilisphaera perlucida Assemblage," largely Aptian in age.

77RF 2

The samples yielded rich microplankton floras with Dimidiadinium uncinatum, Pseudoceratium nudum Batioladinium pelliferum, B. longicornutum, Muderongia tetracantha, M. staurota, etc., diagnostic species for the "Dimidiadinium uncinatum Assemblage" of Barremian age.

77RF 3A

The sample yielded a moderately rich microplankton flora with Lunatadinium dissolutum (dominant), Tanyosphaeridium cf. variecalamum, Gardodimium trabeculosum, Dimidiadinium uncinatum, etc., typical for the "Lunatidinium dissolutum Assemblage" of Hauterivian age.

77RF 5A

The sample yielded an extremely poor, badly corroded flora with some Dinolflagellate remains. No age assigment possible.

77RF 7

The sample yielded an extremely poor, moderately to badly corroded microplankton flora with a few recognizable specimens of Tubotuberella rhombiformis and of Scriniodinium sp. indet.. If these specimens are in situ (and not recycled) this flora could possibly belong to the "Tubotuberella rhombiformis Assemblage" of Valanginian to Berriasian age, or it could even belong to the "Sirmiodinium grossi (B) Assemblage" and be as old as Berriasian to Portlandian in age.

77RF 8

Only a few Dinoflagellate remains, the majority of which with a Peridinioid outline, were recovered from sample 77RF 8-1. No age assignment possible.

77HW 8

The samples contained modest microplankton floras with Endoscrinium cf. luridum, Pareodinia ceratophora, P. borealis, Sirmiodinium grossi (B), Tubotuberella rhombiformis, etc., and are considered to belong to the "Sirmiodinium grossi (B) Assemblage" of Portlandian to Berriasian age.

77RF 10

The samples yielded very poor, badly corroded microplankton floras, with only Gonyaulacysta jurassica longicornis as the significant Dinofloagellate cyst. It is thought therefore that these samples belong to the "Gonyaulacysta jurassica longicornis Assemblage" of Kimmeridgian to Oxfordian age.

77RF 13

The samples yielded badly corroded microfloras; no Dinoflagellates were observed, only a few speciments of Cicatricosis-porites sp. indet. No age assignment was possible.

77RF 11

The sample yielded a very poor, badly corroded, microplankton flora with only a few specimens of Cleistopsphaeridium sp. indet., Palaeostomocystis fragilis, and Deflandrea sp. indet. Age: Upper Cretaceous s.l. No assignment could be made to any specific assemblage.

77RF 15

Samples 1, 2, and 4 contained poor microplankton floras with Deflandrea biapertura, D. sp. indet., D. cf. minor, Wodehouseia spinata, Aquilapollenites cf. quadrilobus, A. spp. indet., etc., which are all considered to belong to Upper Cretaceous microfloral assemblages. (The exact assemblage could not be defined.)

Sample 3 near the top of the section, contained a few specimens of Deflandrea sp. indet., (Upper Cretaceous forms) and a host of typical Lower Cretaceous forms, such as Lunatadinium dissolutum, Prionodinium alveolatum, Dingodinium cerviculum, etc. Also more typical (Upper Albian to) Cenomanian forms were present such as Ovoidinium verrucosum, cf. Luxadinium

propatulum, ?Spinidinium cf. vestitum, etc., most of these Lower Cretaceous and Cenomanian species were represented by one (or a few) specimens only. It is thought that this sample is of Upper Cretaceous (s.l.) age, and contains numerous Lower Cretaceous, and possibly Cenomanian, recycled forms.

77HW 9

Poor microplankton floras (badly corroded) with Palaeoperidinium cretaceum, Cribroperidinium edwardsii, Odontochitina operculata, Oligosphaeridium complex, ?Muderongia sp. indet., etc. None of the recorded species is characteristic for a specific microfloral assemblage, although their occurrence suggests a Lower Cretaceous age for this section.

77RF 18

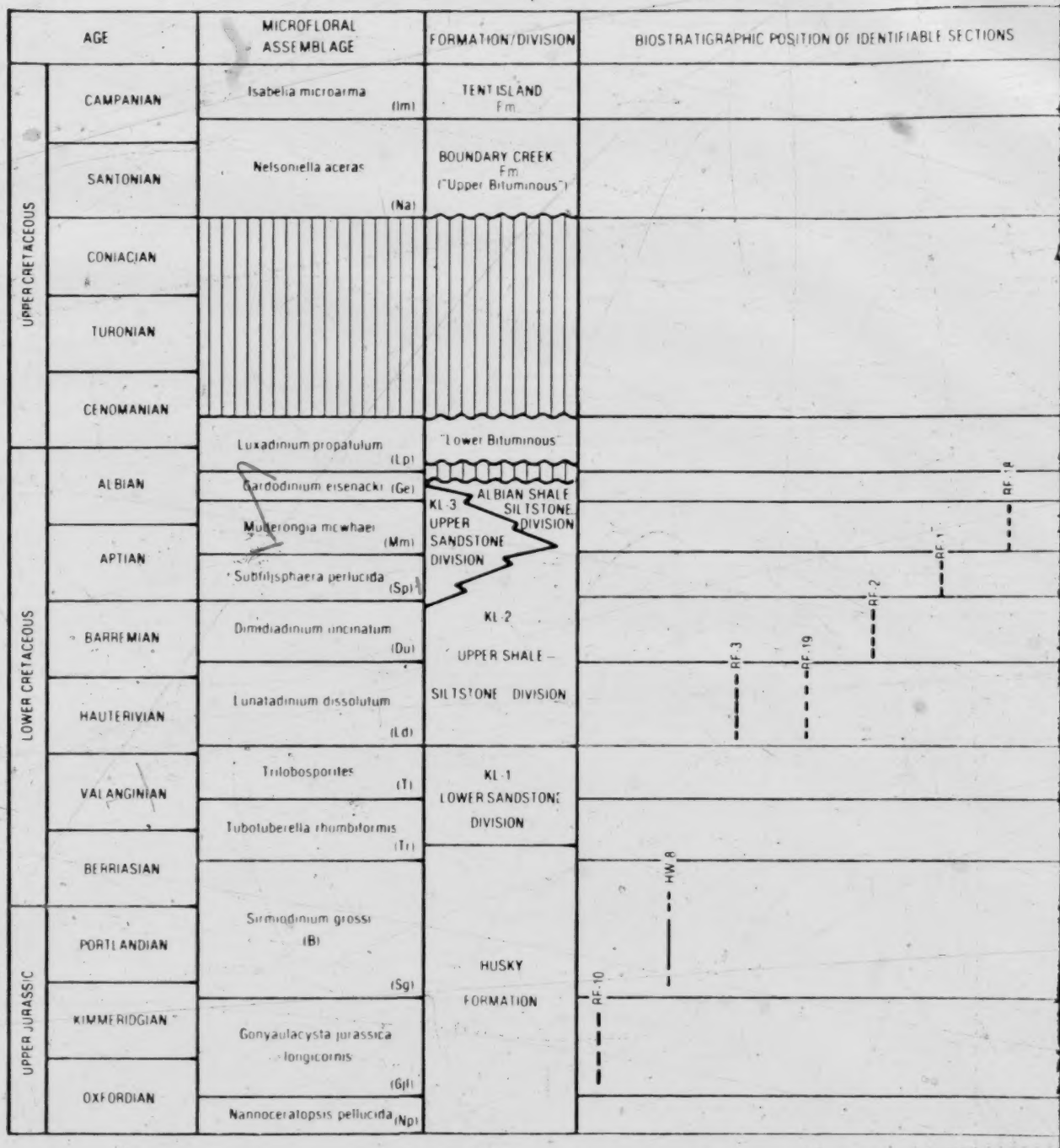
The samples yielded rather modest microplankton floras with Muderongia sp. indet., M. sp. (A), Pseudoceratium nudum, Tenua spp., etc. None of the recovered species are diagnostic of a specific microplankton assemblage, but it is possible that this flora belongs to the "Muderongia mcwhaei Assemblage" of Lower Albian to Aptian age.

77RF 19

The sample yielded rather modest microplankton floras with badly corroded specimens of Lunatadinium dissolutum (common, or possibly abundant), Dimidiadinium uincinatum, Odontochitina operculata, Gardodinium eisenacki, etc.
It is difficlut to relate these floras to a specific microfloral assemblage. The presence of Dimidiadinium uncinatum (rare, in sample 77RF 19-3) suggests that this section is not younger than the "Dimidiadinium uncinatum Assemblage" (Barremian) and the possible abundance of Lunatadinium dissolutum could be an indication that these floras are comparable to the "Lunatadinium dissolutum Assemblage" (Hauterivian).

77PS 7

The samples yielded badly corroded modest microplankton floras with Muderongia mcwhaei, M. sp. indet., Oligosphaeridium complex, Odontochitina operculata, Palaeoperidinium cretaceum, Gardodinium eisenacki, etc. Assignment to any specific microfloral assemblage was not possible, and only a general Lower Cretaceous age could be assigned to this section.



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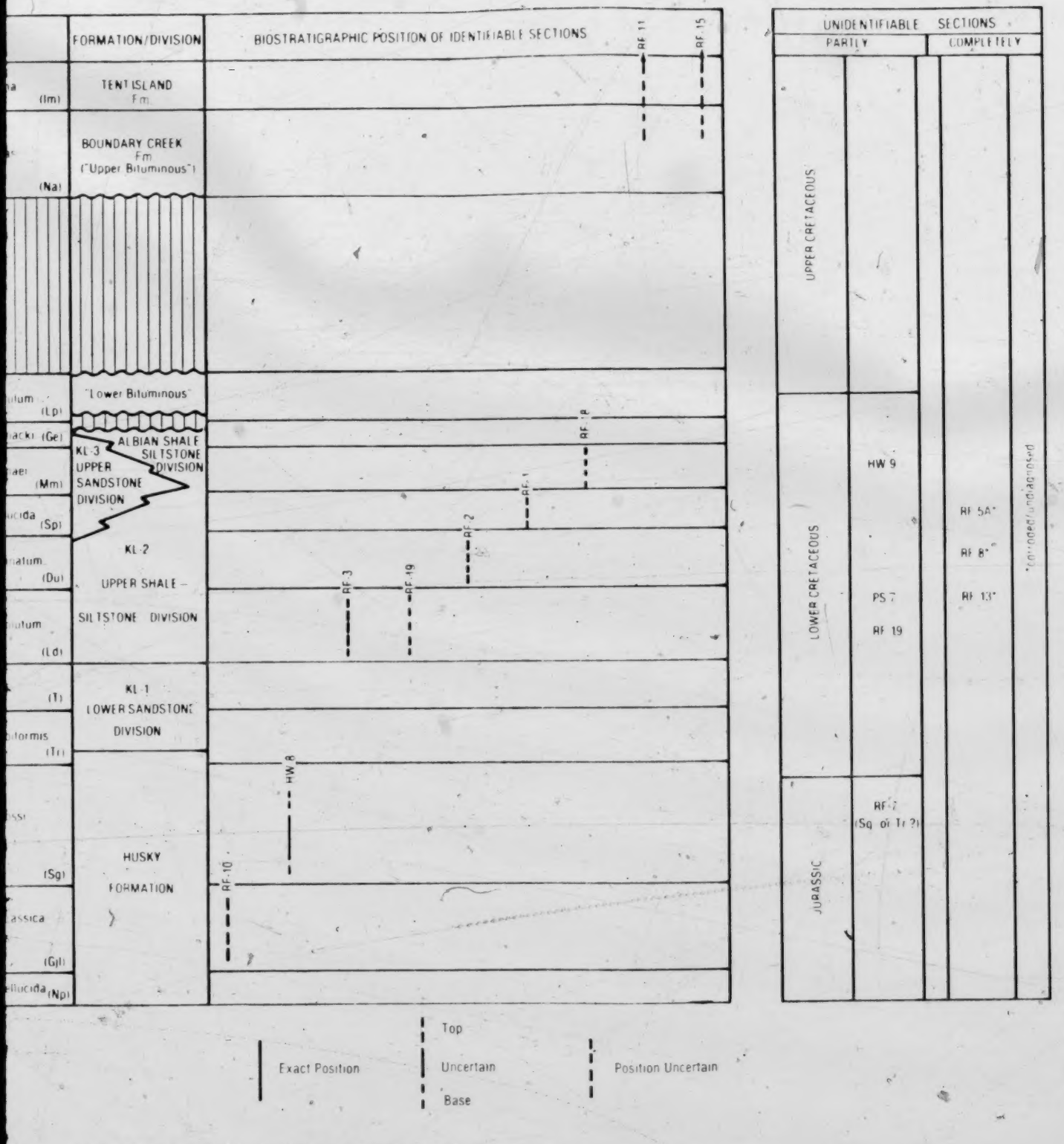
SUMMARY OF PALYNOSTRATIGRAPHIC ANALYSES



SUMMARY OF PALYNOSTRATIGRAPHIC ANALYSES

2 of 2

APPENDIX 6. Stellate Nodules

Stellate nodules, also known as hedgehog concretions are spheroidal aggregates of crystals, considered to have formed under cold water, high latitude conditions (Kemper et al., 1975, p.109). Compositionally, stellate nodules are thought to be calcite pseudomorphs after thenardite. They have also been identified as siderite pseudomorphs after glauberite. According to Kemper et al. (1975),

> "To date 'hedgehogs' are unknown in the Cretaceous of the Canadian mainland (J.A. Jeletzky, oral comm., December 12, 1974), in USSR, and even in East Greenland".

Crystal aggregates thought to be stellate nodules are present at two locations along Cache Creek, in outcrops HW 9 and PS 7. At both sites, the nodules are found in thin sandstone beds within an interbedded sandstone, siltstone and shale sequence. The nodules are of variable size (see following plate). Their composition, as determined from x-ray diffraction analyses is a calcium (manganese, magnesium) carbonate.

Stellate nodules from outcrops HW 9(left) and PS 7(right).